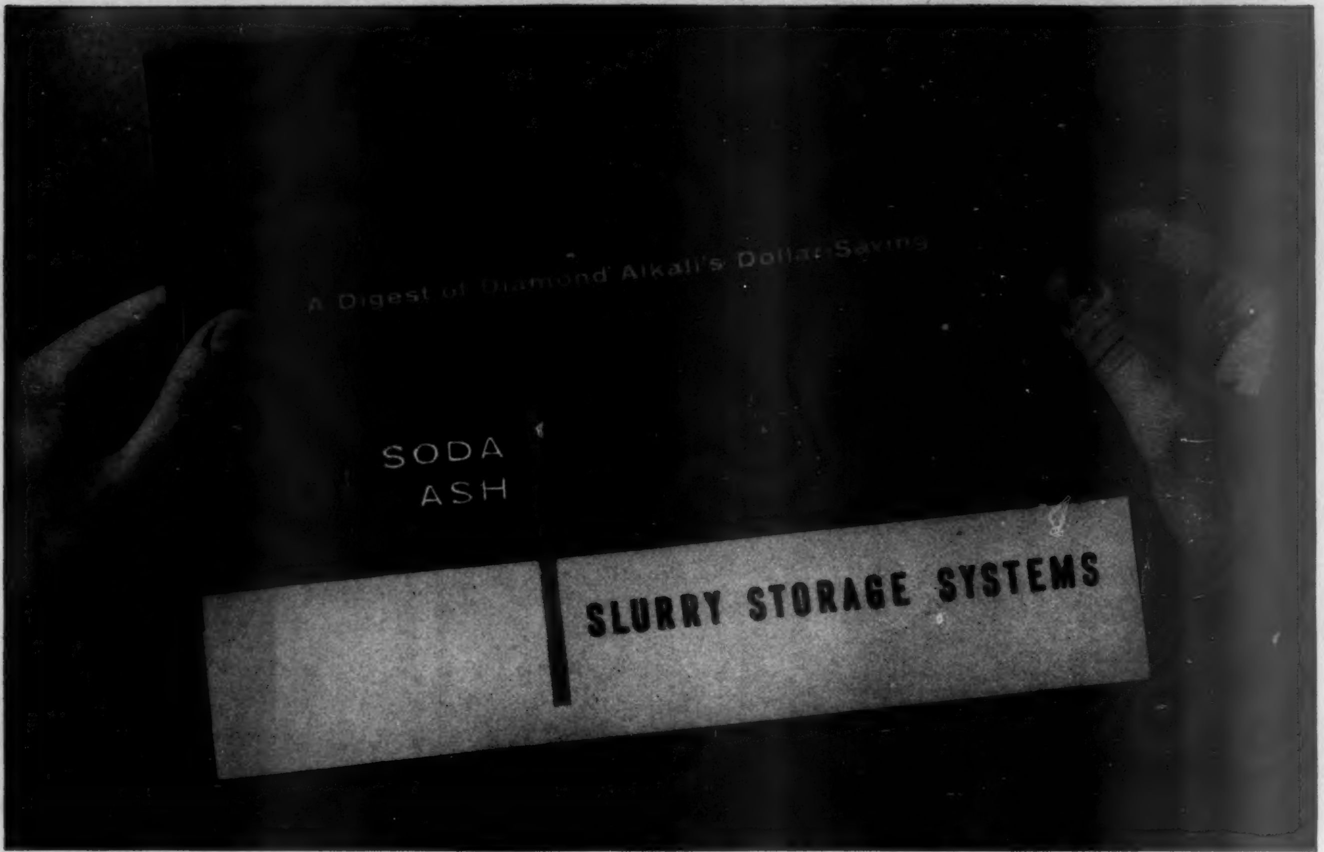
ARMED FORCES CHEMICAL JOURNAL

—U. S. Army Photo

ARMED FORCES DAY—MAY 17

MARCH-APRIL 1958



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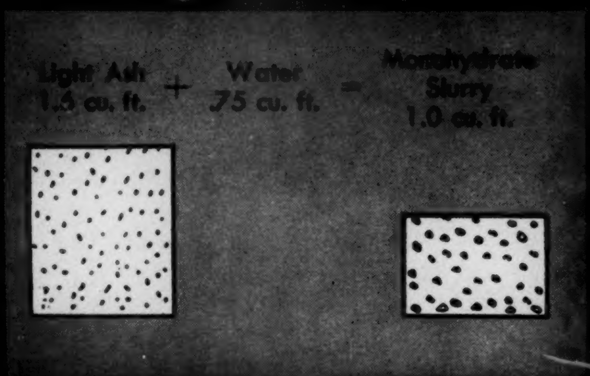

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Armed Forces CHEMICAL JOURNAL

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The fact that an article appears in this magazine does not indicate approval of the views expressed in it by any one other than the author. It is our policy to print articles on subjects of interest in order to stimulate thought and promote discussion; this regardless of the fact that some or all of the opinions advanced may be at variance with those held by the Armed Forces Chemical Association, National Officers, and the Editors. It is the responsibility of contributors, including advertisers, to obtain security clearance, as appropriate, of matter submitted for publication. Such clearance does not necessarily indicate indorsement of the material for factual accuracy or opinion by the clearing agency.

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COVER PHOTO

Our basic strength — patriotic American Youth in uniforms of the Armed Forces: Army, Marine Corps, Navy, Air Force, and Coast Guard. May 17 will be Armed Forces Day and there will be "open house" observances at most all military and naval posts, camps or stations during the period May 10-18. The public is invited.

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ADVERTISERS

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ARMED FORCES CHEMICAL ASSOCIATION

National Headquarters

408-410 Park Lane Building—2025 Eye Street, N.W.

WASHINGTON 6, D.C.

(Republic 7-6803)

The members of this Association, mindful of the vital importance to national defense of chemistry, allied sciences, and the arts derived from them, have joined together as a patriotic obligation to preserve the knowledge of, and interest in, national defense problems derived from wartime experience; to extend the knowledge of, and interest in, these problems; and to promote cooperative endeavor among its members, the Armed Services, and civilian organizations in applying science to the problems confronting the military services and other defense agencies, particularly, but not exclusively in fields related to chemical warfare. (From Art. II, AFCA Constitution.)

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A. F. C. A. AFFAIRS

EGBERT FRANK BULLENE

Major General Egbert Frank Bullene, USA (Retired), former Chief Chemical Officer of the Army, a Director-at-Large of the Armed Forces Chemical Association, died on February 21, 1958, at The Letterman General Hospital, San Francisco, Calif. He was 63. Burial was at the National Cemetery at The Presido of California, San Francisco. General Bullene is survived by his widow, the former Lois Esther Salsman, and son, Roger, midshipman at the United States Naval Academy, Annapolis, Md.

General Bullene was born at Salinas, Calif., January 25, 1895. He attended the Naval Academy but on graduation in 1917 transferred to the Army receiving his first commission as 2nd Lieutenant of Cavalry. In World War I, assigned to combat duty in the American Expeditionary Forces in France, he served in the Field Artillery as a battery officer and later as battery commander after his superior officer was killed in action. While overseas he received a temporary promotion to the grade of captain although he was then but twenty-four years old. Wounded in action he was awarded the Purple Heart.

After World War I, General Bullene served in the First Cavalry Division. In 1925 he was detailed to duty to the Chemical Warfare Service (now the Chemical Corps) and had extensive service in the First Gas Regiment which was the chemical troops organization of World War I. In 1928, he transferred to the C.W.S. and subsequently served on a number of assignments including duties as student and instructor at the Command & General Staff School and student at the War College.

During World War II, Bullene was promoted to the grade of Brigadier General. He served as commander of the Chemical Troops Training Center; as Chemical Officer of the Armored Force, and as Commanding General of the San Jose Project. He also had service in both the European and Far Eastern theatres of operation.

After World War II, General Bullene served as Commanding General, Army Chemical Center, Maryland. He was appointed Chief Chemical Officer of the Army on June 21, 1951. Upon retirement March 31, 1954, he and his family returned to his native California, making their home at Carmel.

General Bullene's decorations included the Legion of Merit, the Bronze Star Medal, the Purple Heart and the Army Commendation Ribbon.

HANS STAUFFER MADE MEMBER OF INDUSTRIAL CONFERENCE BOARD

Mr. Hans Stauffer, President of Stauffer Chemical Company, New York, has been elected a board member of the National Industrial Conference Board.

The Board founded in 1916, is an independent nonprofit institution for business and industrial fact finding through scientific research. The work of the Board is made possible through the support of more than 3,600 subscribing associates including business organizations, trade associations, government bureaus, labor unions, libraries, individuals, and colleges and universities.

MR. C. DUDLEY CLAWSON

Mr. C. Dudley Clawson, who was president of Ferro Corporation, and a former Director-at-Large of A.F.C.A., died on January 4 from a heart attack while on a trip in Mexico City, Mexico. He was 55.

Mr. Clawson was born April 6, 1902, in Hamilton, Ohio. He received a degree in Ceramic Engineering from Ohio State University in 1925, and in 1956 received a distinguished alumnus award from the University. He attended the Harvard Management course in 1953. Mr. Clawson was very active in civic and professional affairs and was a member of many national and Cleveland organizations. He was a member of the Phi Delta Theta fraternity, and the Al Koran Temple, Lake Erie Consistory of the Masonic Order.

Mr. Clawson is survived by his wife, Inga B., three sons, his mother, and four grandchildren.

NEW BOOKLET TELLS OF BENEFITS FOR VETERANS

A new booklet, "Federal Benefits Available to Veterans and Their Dependents," is on sale at the U.S. Government Printing Office in Washington, D.C., for 15 cents a copy, with a 25 per cent discount for 100 or more copies. The booklet explains all major U.S. veterans' benefits, the elegibility requirements for each benefit, and where to apply.

A. F. C. A. AFFAIRS

NOTICE TO CHAPTERS

To permit more time for the selection of candidates for the Science Teacher Award to be made—the closing date for entries has been extended from March 31st to midnight April 15th.

HARRY T. MARKS BECOMES THE NEW PRESIDENT OF FERRO CORP.

Mr. Harry T. Marks, 49, executive vice president, was elected president of Ferro Corporation on January 21 at a meeting of the firm's board of directors. Mr. Marks who is a 25-year veteran of Ferro will continue to carry out his present duties while assuming the position made vacant early this month by the sudden death of Mr. C. D. Clawson.

Born and educated in Canada, Mr. Marks first joined the concern's Canadian subsidiary in 1933 as plant superintendent and subsequently has held the positions of Export Manager, managing director of Ferro Brazil, manager of the international division, vice president—foreign operations, vice president—administration, and, in 1955, he was advanced to executive vice president.

FRED HICKEY HEADS PITTSBURGH CHAPTER

Mr. Fred Hickey of 433 Fisher St., Pittsburgh, is the new president of the Pittsburgh Chapter, Armed Forces Chemical Association. Mr. Charles A. Kiernan has been elected secretary-treasurer.

Mr. Hickey, who succeeds Mr. S. C. Colbeck, is with the Defense Products Department of Mine Safety Appliances Company.

DIAMOND TO TERMINATE PINE BLUFF PLANT LEASE

The Diamond Alkali Company, Cleveland, Ohio, has notified the U.S. Government that the Company will terminate April 27, 1958, its lease for the operation of the chlorine-caustic soda plant at the Pine Bluff Arsenal, Pine Bluff, Arkansas, a Chemical Corps installation.

Mr. Frank Chrenick, General Manager of Diamond's Electro Chemicals Division, said that the Company's production facilities at Muscle Shoals, Alabama and at Deer Park, Texas, "have made it possible for us to produce these two basic chemicals in the same volume more efficiently and at lower cost than possible at Pine Bluff. . . ."

Mr. Chrenick pointed out that a major factor in Diamond's decision was the recent abandonment of DDT production at Pine Bluff by Niagara Chemical Division of Food Machinery and Chemical Corporation. DDT is an important agricultural chemical requiring chlorine in its production.

SOLID FUEL MISSILE TO REPLACE REDSTONE

The Army has received instructions from the Secretary of Defense to provide on a top priority basis for the development of a solid propellant ballistic missile to succeed the REDSTONE missile which operates with liquid propellant.

The REDSTONE missile is mobile, field worthy and accurate, Secretary McElroy pointed out. However, he said, recent advances in solid propellant technology resulting in large part from the Army's SERGEANT and the Navy's POLARIS programs make it possible to start development without delay of this solid propellant missile. The new missile, to be called PERSHING after General John J. Pershing, will be smaller, lighter and even more mobile than the REDSTONE.

The new solid propellant missile, it is stated, will provide the Army a more versatile and flexible weapon with which to discharge its role on the battlefield of the future.

DR. WILLIAM O. BAKER JOINS BOARD OF MELLON INSTITUTE

Dr. William O. Baker, Vice President—Research, Bell Telephone Laboratories, Murray Hill, N.J., has been appointed to the Trustees' Scientific Advisory Board of Mellon Institute, according to an announcement by Matthew B. Ridgway, the Trustee Chairman. In this post Dr. Baker will team with the other Board members—Dr. George O. Curme, Jr., Director, Union Carbide Corporation; Dr. Lee A. DuBridge, President, California Institute of Technology; and Dr. Warren C. Johnson, Dean of the Division of Physical Sciences, University of Chicago—and with Dr. Paul J. Flory, the Institute's Executive Director of Research, in charting researches of the organization.

Dr. Baker, born in 1915, received his education at Washington College (B.S., 1935) and at Princeton University (Ph.D., 1938). During 1944 he was with the Office of Scientific Research and Development and the Office of Rubber Reserve in Washington. His main research interests have related to the dielectric properties of organic solids, to the molecular weight structure and dynamics of chain polymers, and to synthetic rubber.

—Central Studios Photo

13TH ANNUAL MEETING

THE Annual Meeting of A.F.C.A. this year—its 13th consecutive gathering—will be held in Atlantic City, New Jersey, June 5 and 6, at The Traymore located on the famous Boardwalk. Provisions will be made to take care of early registrants on June 4.

The "host service" for this meeting will be the Army —it being the Army's turn this year in accordance with the now well-established practice to call upon each of the Armed Services in regular rotation for special support and assistance. This role for the 1958 meeting has been graciously accepted by Secretary of the Army, The Honorable Wilber M. Brucker, in a letter (see letter on opposite page) to Dr. Wendell F. Jackson, of E. I. duPont de Nemours & Company, Wilmington, Del., Vice President of the Association for Meetings.

The theme for this year's program, purposely broad in scope so as to allow for a variety of presentations, is "The Role of the Army in Modern Warfare."

It is expected that the Chemical Corps will take a prominent part in the meeting. However, the program will not be confined to Chemical Corps presentations. It is definitely planned also to have contributions from other Arms and Services. In addition, it is expected that there will also be participation by both the Navy and the Air Force, even though this is the Army's turn for "top billing."

Arrangements to insure a broad, comprehensive program are reflected in Secretary Brucker's letter. He has noted that Major General Harry P. Storke, the Army's Chief of Information, is to appoint an officer as Liaison Officer to represent the Armed Services. The liaison officer for the Chemical Corps' participation, already designated, is Lt. Colonel Timothy C. Williams, of the Chief Chemical Officer's Staff.

Both Wilmington and New York Chapters of A.F.C.A. are joining forces this year as the sponsoring A.F.C.A. Chapters for the meeting, and from them, as well as the Washington Chapter, Dr. Jackson has appointed his General Committee on Arrangements.

(Continued on Page 8)

THE ARMY TO BE THE "HOST SERVICE" THIS YEAR

Letter of Acceptance by Secretary Brucker

DEPARTMENT OF THE ARMY
WASHINGTON 25, D. C.

IN REPLY REFER TO:

FEB 11 1958

Mr. Wendell F. Jackson
Explosives Department
E. I. duPont de Nemours & Company, Incorporated
Wilmington 98, Delaware

Dear Mr. Jackson:

This will confirm our agreement that the Army will act as host service to the thirteenth annual meeting of the Armed Forces Chemical Association on 5 and 6 June 1958. The Army will be happy to have this opportunity to bring to the attention of your members the very important role of the Army in modern warfare.

In order that our part in your program will be truly representative of the role of the entire Army, I have asked Major General Harry P. Storke, the Army Chief of Information, to arrange for the Armed Services Representative for this meeting. This officer will contact you shortly and will be available to make necessary arrangements for Army participation at the meeting.

Assisting the Armed Services Representative will be Liaison Officers from the several Technical Services of the Army to insure a broad presentation of the Army story.

It was a pleasure talking with you during your visit to my office and I wish you much success in your plans for the coming meeting of your organization.

Sincerely yours,

Wilber M. Brucker

Wilber M. Brucker
Secretary of the Army

PRESIDENT'S COMMENTS

13th ANNUAL MEETING OF A. F. C. A.

Our 13th Annual Meeting of the ARMED FORCES CHEMICAL ASSOCIATION will be held this year on June 5 and 6 at the popular vacation spot, Atlantic City, with headquarters at the beautiful Hotel Traymore. The "host service" this year will be the United States Army.

The theme for this meeting is:—

"THE ROLE OF THE ARMY IN MODERN WARFARE"

Dr. Wendell F. Jackson, A.F.C.A. National Vice President for Meetings, started many weeks ago selecting an able and hard-working committee. This group has been actively and energetically working to make this a record meeting. Since our membership is vitally interested in problems of national defense, we are asking the Army to tell us what its job is at this point in history and how it is going about doing it. The formal program consists of a series of talks on Thursday afternoon, June 5, and a morning and afternoon session on Friday, June 6, closing with our famous banquet on Friday evening. We guarantee "ideal" weather for this meeting.

Looking forward to seeing your wife and yourself at our

13TH ANNUAL MEETING IN ATLANTIC CITY

June 5 and 6, 1958

Cordially,

Glenn A. Hutt

(Continued from Page 6)

Advance Registration Urged

At this writing, shortly before press time for the Journal, details of the program are in process of development. It is expected, however, that the schedule for the two-day session, including special features for the wives and daughters of members attending, will be firm by sometime in April or early in May. Dr. Jackson plans then to send out to all members a bulletin-type notice of the forthcoming meeting, including the schedule of events, and also a blank form for advance registration. He urges that all who are reasonably certain they will attend the meeting register by mail in advance. This will materially assist the Committee in its administrative arrangements and financial plans. Members who desire to obtain hotel accommodations at The Traymore are urged to make early reservation of hotel space. The Traymore rates are from $8 up for a single room and from $10 up for double occupancy rooms.

In addition to the program for the membership in general, there will also be held at this time the regular annual meeting of the Board of Directors for the transaction of current business, and election of officers of the Association for the coming year. Under the constitution of A.F.C.A., the election this year will require the selection of a new President, since the incumbent, Mr. Glenn Hutt, of Cleveland, will complete his second term as President with this meeting. A general business meeting open to the entire membership will also be held. As usual, the President's reception followed by the annual banquet will conclude the program.

The Chemical Corps and, possibly, other agencies of the Department of Defense, will display exhibits of Service materiel and equipment. A number of new items and features have been added to the Chemical Corps exhibit since it was first shown to the Association at the Annual Meeting in Cleveland in 1955.

Second Time at Atlantic City

This meeting will be the second in the history of A.F.C.A. to be held in Atlantic City. The first occasion was the 6th Annual Meeting in 1951, during the presidency of Dr. Walter E. Lawson. In deciding upon Atlantic City for this year, the Executive Committee felt that this selection would give to the meeting a twofold appeal, providing not only a program of broad military interest but also an opportunity for pleasure and recreation at this famous resort and popular convention city. While it is realized that many members, no doubt, have visited Atlantic City before, it is also thought that perhaps there are many others who have not yet had that opportunity and pleasure. In either case, the Committee feels Atlantic City will appeal. The city covers an island about ¾ miles wide and 10 miles long, separated from the mainland of New Jersey by a narrow strip of water. Favored by the Gulf Stream for a mild winter climate

(Continued on Page 10)


MOLDED FIBER GLASS
RUBBER DRUMS
GASKETS
VIBREX
GAS MASKS
VIBRATION MOUNTS

1958 MEETING CHAIRMAN

DR. WENDELL F. JACKSON

A.F.C.A.'s Vice President for Meetings, in general charge of arrangements for the 13th Annual Meeting, Atlantic City, June 5 and 6, is Wendell Ford Jackson.

Dr. Jackson is Assistant Manager, Research Division, Explosives Department, E. I. duPont de Nemours & Company, Wilmington, Delaware. He was born in New York, N.Y., November 25, 1907; has AB, Masters and a Ph.D (Chemistry) degrees from Princeton.

Dr. Jackson was Assistant in Chemistry at Princeton, 1931-32 and a Research Fellow at the California Institute of Technology, 1933-34. He joined Du Pont in 1935.

In 1947 Dr. Jackson served as an Observer with the U.S. Army Arctic Task Forces in Alaska. He has served in an advisory capacity to the Naval Powder Factory, Picatinny Arsenal, Office of Scientific Research and Development of the Navy.

Dr. Jackson resides at 905 Overbrook Road, Westover Hills, Wilmington, Delaware. He is a member of various scientific and technological societies and the author of a number of scientific papers dealing with ballistics and explosives.

13th ANNUAL MEETING

(Continued from Page 8)

and by sea breezes in summer, it is a popular recreation resort for practically all-year-round use. The transient population—the city having a great many hotels—exceeds several times over the number of permanent residents.

THE General Committee on Arrangements assisting Dr. Jackson consists of the following:

GENERAL COMMITTEE

Member Ex Officio: Glenn Hutt, Ferro Corp., Cleveland, O.
Vice Chairmen: New York—R. W. Eddy, Union Carbide Corp. Wilmington—C. H. Carter, Atlas Powder Co. Washington—Col. H. A. Kuhn, Consultant
Military Liaison: Lt. Colonel Timothy C. Williams, Cml. C.

SPECIAL COMMITTEES—CHAIRMEN

Arrangements and Banquet: New York—Walter H. Sykes, Allied Chemical & Dye Corp.
Exhibits: Wilmington—Henry Marsh, Hercules Powder Co.
Program, Publicity and Advertising: New York—Joseph Keneally, Union Carbide Corp.
Finance: New York—Joel Henry, American Institute of Chemical Engineers
Transportation: Wilmington—A. P. Storm, E. I. duPont de Nemours & Co.
Ladies' Entertainment: Wilmington—Mrs. Wendell F. Jackson
Registration: Joint responsibility of National Headquarters and Chapters.

Colonel P. B. Melody, Army Information Office, has been designated as Armed Services Representative for the meeting.

PRESIDENT HUTT ATTENDS FOREIGN AID CONFERENCE

The President of the Armed Forces Chemical Association, Mr. Glenn A. Hutt of Cleveland, was among the assemblage of national leaders who attended the non-partisan Conference on foreign aid and mutual security in Washington on February 25. The full day meeting was arranged at White House request by Mr. Eric Johnston, president of Motion Picture Association of America and former president of the Chamber of Commerce of the United States. Speeches in support of a vigorous foreign aid program, both military and economic, in the interest of the free world, were made by President Eisenhower, Former President Harry S. Truman, Vice President Nixon, Secretary of State Dulles, Mr. Adlai Stevenson, and other notables.

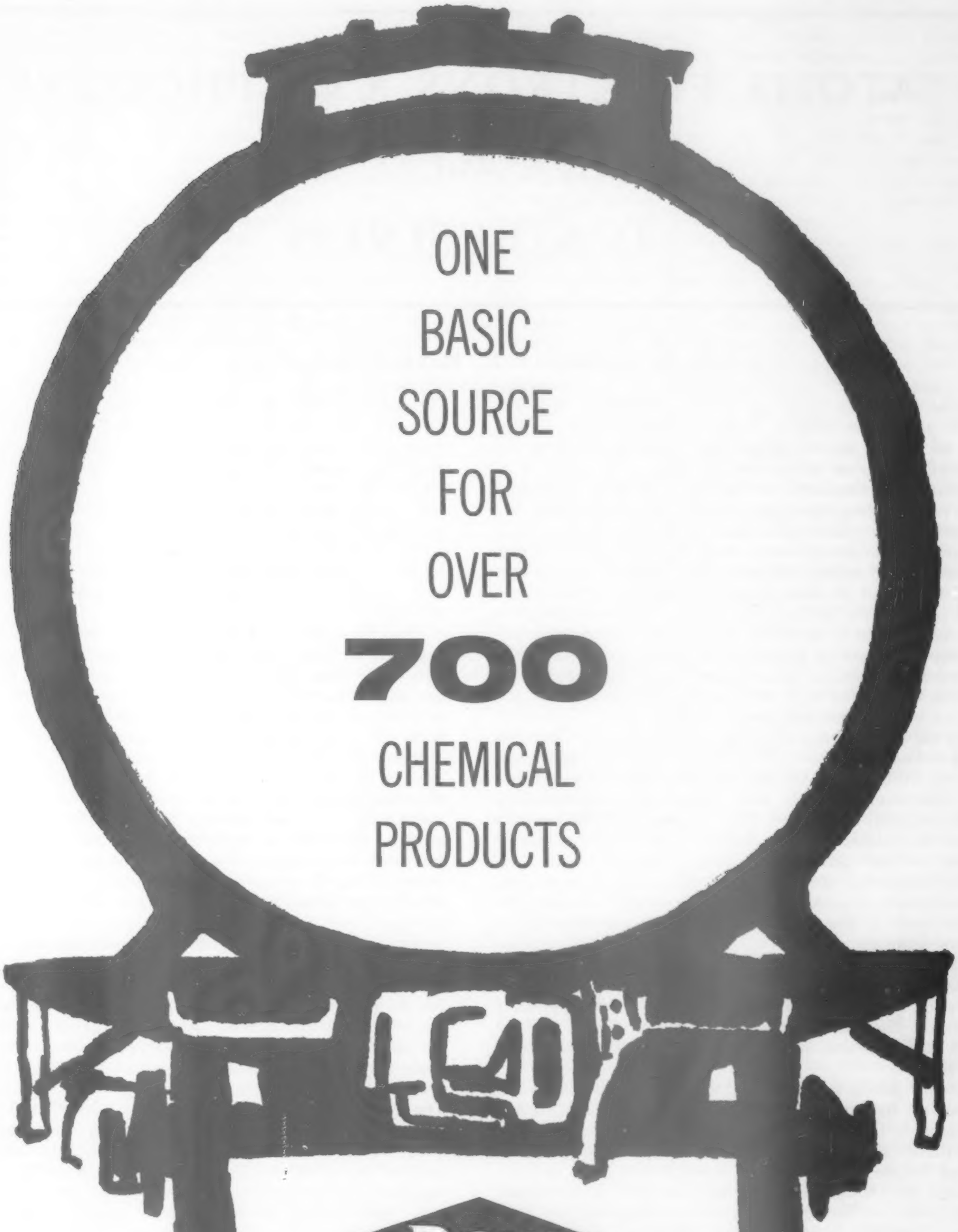
ARMY'S NEW R&D CHIEF

Lieutenant General Arthur G. Trudeau is the Army's new chief of Research and Development, succeeding Lieutenant General James M. Gavin due to retire on March 31, 1958.

General Trudeau, 55, a West Point graduate, served in the European, North African and Southwest Pacific Theaters, chiefly as an amphibious warfare expert, in World War II, and subsequently served in Washington as the Army's Assistant Chief of Staff for Intelligence.

He commanded the 1st Cavalry Division in Hokkaido, Japan, from July 1952 until March 1953, when he was appointed Commanding General of the 7th Infantry Division in Korea.

From October 1956 until his recent orders to the Pentagon, he served as Commander of the I Corps (Group), U.S. Army Forces in Korea.


ONE
BASIC
SOURCE
FOR
OVER
700
CHEMICAL
PRODUCTS

ATOMS, ELECTRONS AND PHOTONS

and

U. S. BUSINESS

Donald H. Hale, Ph.D.
Colonel, USA-Retired

THE impact of the atomic age upon business in the United States is being felt. It appears reasonable to predict that this new technology will have a rapidly increasing effect upon most types of business and industry in the years just ahead. It becomes increasingly clear that the use of atomic energy presents new sources of power and makes available new types of energy that will be useful in most types of industry, in medicine, and in research. In the years since 1945 much progress has been made in applying atomic energy and radiation in many phases of industry. Sufficient experience has now been gained for it to be possible to make estimates of the use of the new technology in business and industry in the years just ahead.

At the end of June, 1957, the Atomic Energy Commission released a list of 1,327 permits for access to atomic energy information. Of this list 138 permits were issued to individuals, schools and government organizations both national and state. The remaining 1,189 permits went to business and industrial concerns. Not all of these are now using atomic energy and its products in their industries and businesses. Many are carrying on development programs and some are only following developments in the atomic field. But all are showing an active interest.

Chauncey Starr, General Manager of Atomic International, estimates that in the period 1956 to 1965 U. S. industry will have about four billion dollars of reactor business. He also estimates that in the period 1966 to 1975 this business will amount to twenty-two billion dollars.

Atomic power has attracted the most public attention. However, by no means is all of the industrial interest directed to this phase of the uses of the atom.

Willard F. Libby, Atomic Energy Commissioner, stated before the UNESCO Conference in Paris in September 1957 that at the present time 1,667 U. S. industrial firms are using radioactive isotopes and he predicts a five-fold increase in this use within the next ten years. At the end of 1956 there were 3,663 organizations in the U. S. that were licensed to use radioactive isotopes.

The use of radiation to induce chemical reaction is a new tool that promises real advantages for industry. Tagged radioactive atoms are an excellent tool for chemical and other research. Atomic radiation is being widely used in medical treatment and research.

It is not possible to estimate the resesearch and development effort in this country in the new atomic fields. All the evidence indicates that the present effort is large and that it is growing rapidly.

Several types of reactors have been built in this country. Among these are:

- Training Reactors
- Research Reactors
- Materials Testing Reactors
- Power Recators for Electrical Power
- Power Reactors for Ship Propulsion

Training reactors have been built in many power ratings but in ratings less than that of the power reactors. They are used for college level training and for the training of technicians who assist in operating the larger reactors. In general the training reactors are designed with safety as the primary consideration.

Research reactors have been designed and used for a variety of purposes. In general they are used to study the neutron flux of various reactor fuel arrangements, the action of cooling systems, and the effects of reactor neutron and gamma radiation upon various materials and also as a source of neutrons for experimental investigations. They are also used to test the efficiency of shields and shielding materials. They are often used to produce small amounts of radioactive materials for research. The research reactor can also be used for training.

Materials testing reactors are designed specifically for the purpose of determining under realistic conditions the effects of neutron and gamma radiation upon materials used for engineering purposes. In general the materials of interest are those which may be used for reactor fabrication but other equipment is also tested. The Armed Forces, as an example, are interested in the effects of neutron radiation upon many electronic devices. They want devices which will operate after exposure to neutrons in an atomic explosion. These reactors are designed to produce intense neutron radiation, much more intense than is encountered in the power reactor. This intense neutron radiation makes it possible in a few days to determine the effects of months of exposure in a power reactor. They also are designed with openings so that samples to be tested can be placed within the reactor.

Nuclear reactions produce energy, radiation and radioactive by-products which are generally referred to as radioactive isotopes. At the present time, and in the present state of development, the energy produced is in the form of heat. The heat is then converted into elecetrical energy. There is no reason that this heat cannot also be used for space heating or as process heat in the chemical and other industries. It has already been seri-

ously suggested that the time is near when nuclear heat might be feasible for use in those industrial processes which require relatively low temperatures, that is temperatures below about 300 degrees F.

As the large power reactors come into use large amounts of radioactive material will be produced as by-products. Over 200 different radioactive atoms are generated. This material must either be disposed of or ways found for its utilization. Several small companies have been recently formed and have gone into the business of disposing of radioactive wastes. It will be more economical to find ways to utilize these wastes. The AEC is aware of this problem and has several contractors at work. It is estimated that a concern operating a large power reactor could rent used fuel rods as a source of industrial radiation and that this service might bring in a million dollars in added income each year.

These radioactive isotopes must be handled with some care to prevent injury to workers. Great care must be exercised in their disposal. Some of them have industrial importance and it is likely that research will discover uses for others.

The neutrons generated by the reactor while operating have the power to make some materials radioactive. Thus the action of neutrons upon cobalt produces cobalt-60, a radioactive form of cobalt which emits gamma radiation. This gamma radiation is akin to the radiation produced by the x-ray tube. Cobalt-60 is finding many uses in industry and medicine. It is estimated that cobalt-60 will eventually replace the x-ray tube for use in medical treatment. Cobalt-60 has been produced in this country largely by the AEC.

There are many materials which can be made radioactive by exposure to neutrons. These emit gamma radiation and/or high speed electrons. They emit radiation of differing penetrating power and emit in differing amounts. Thus it is possible, to a degree, to tailor a radioactive material to a task.

The new technology has made radiation available in amounts far beyond anything ever imagined a few years ago. Also, today, there are types of radiation readily available that were laboratory curiosities until recently. Alpha, beta and gamma radiations are available from the isotopes separated from the uranium in spent reactor fuel.

Industry has not been slow in searching for applications of this radiation. As has been mentioned many devices using radiation are now available. And industry is busy seeking new ways to use this new tool. Many organizations are carrying on research in this area.

The sources of radiation available for research, industry and medicine may be outlined as follows:

Source	Types of Radiation
Nuclear Reactor (while operating)	Intense gamma and neutron
Nuclear Reactor (by-products)	Alpha, beta & gamma
Nuclear Reactor (by irradiation of inert materials	Alpha, beta & gamma
Natural Materials (such as radium)	Gamma
X-ray Machines	X-ray (gamma)
Electron Machines	Intense beams of high energy electrons (beta)

The nuclear reactor is not, on the whole, a suitable source of radiation for industrial use. It is useful for testing the effects of radiation upon materials and components for use in reactors. Several special "materials testing reactors" have been built for this use.

The radioactive isotopes produced as a by-product of reactor operation are being used in industry. Research in this area indicates that this use will expand. Industrial uses include gauges, atomic batteries and railway signal lamps. As more commercial power reactors are built the amount of this by-product radiation will rapidly increase. From the overall viewpoint of the national economy, it is important that more uses be found for these materials. Gamma radiation has many uses as a research tool and in industry. At the moment the most important use of this radiation is probably in medicine. It is widely used in radiography.

The electron machines are beginning to be used in industry and for research. Some half dozen manufacturers now offer these machines for sale. They are comparatively simple to operate, the shielding requirements are modest and the instrumentation and controls are fairly simple. Special plastics and electrical insulation produced by the use of these machines are now on the market. A number of machines are being used by industry as research tools. The plastics and petroleum people are particularly active in this work. The drug and surgical supply concerns have been active in research and some such supplies now for sale are sterilized by use of radiation produced by the electron machine.

The present electric power generating capacity of the United States is about 120 million kilowatts. This is nearly twice the capacity at the close of World War II. Most authorities agree that the electric power generating capacity will continue to grow and at an accelerated rate. The magazine *Electrical World* (1955) estimates that the total capacity of the country will be 320 million kilowatts by 1970. This is nearly three-fold increase within about fifteen years. The Federal Power Commission (1955) estimates that the country's capacity will only double during this period.

The total national investment in generating, transmission and distributing facilities was about 40 billion dollars in 1955. By the year 1970 this may well be 120 billion dollars.

The most optimistic studies do not predict that more than ten per cent of the total capacity will be generated by atomic plants by 1970. These most optimistic reports predict that atomic power will amount to twenty-five per cent of the total by 1980.

The cost of atomic power produced electricity during this period cannot be estimated with precision. The reactor produced power of today costs several times as much as that produced using conventional fuels. It is predicted that by 1965 atomic plants will be designed that can produce electrical power at a competitive cost, at least in some areas of the country. Since the atomic technology is new, one would predict rapid progress. It is likely that by 1980 atomic produced power will be in a competitive position in any area.

Atomic power will, however, never be free and possibly never much cheaper than power generated by conventional means. Even if the atomic fuels were free there will still remain capital carrying charges, operating, maintenance and transmission costs. Taxes must also be paid. It is not likely that atomic power will have any great effect upon nationwide power costs within the next twenty years. However, atomic power may have a real effect upon the location of industry. Industries requiring large amounts of power may in the future locate in areas without natural fuels. The aluminum producing industry of recent years has been forced to locate its plants near sources of hydro-electric power even if this meant long hauls for raw materials and the product and the establishment of new communities for workers.

The AEC has announced a "power demonstration reactor" program under which it would assist industry by

(Continued on Next Page)

ATOMS, ELECTRONS AND PHOTONS

(Continued from Preceding Page)

bearing a part of development and fuel costs for power reactors. The following nuclear plants have been announced under this program.

Organization and Plant Location	Electrical Power
Power Reactor Development Co. (Monroe, Michigan)	100,000 KW
Yankee Atomic Elec. Co. (Rowe, Mass.)	134,000
Consumers' Public Power District (Hallam, Nebr.)	75,000
Rural Cooperative Power Ass'n (Elk River, Minn.)	22,000
Wolverine Electric Coop. (Hersey, Mich.)	10,000
Chugach Electric Ass'n Inc. (Anchorage, Alaska)	10,000
City of Piqua (Piqua, Ohio)	12,500

In addition to the plants listed above, a number of other atomic power plants are under design or construction or on order in the United States at the present time. Some of these orders are for plants in foreign nations. A summary of this business is given below.

Reactors Operating, Under Construction or on Order (U.S.)	
Number of Reactors Operating in U. S.	45
Number of Reactors Under Construction or on Order, U.S	
a). Research & Test	64
b). Power	60
Number of Reactors Sold by U. S. Firms to Foreign Countries	28

The unit cost of the reactors represented varies from about a hundred thousand dollars upward to a number of millions. The aggregate costs certainly exceeds a billion dollars. Of the total cost of an atomic power plant, about one-fourth represents the cost of the highly specialized equipment such as the reactor, shielding, special handling and special heat extraction equipment.

A number of U. S. industrial firms have built or have orders for reactors. Others are prepared to accept orders. The impact upon U. S. business, however, is much greater than is indicated by the number of these firms. This is so because new materials must be developed, new instruments devised and new fabrication techniques discovered in support of the reactor program. Literally hundreds of U. S. industrial firms are involved. There are possibly fifty concerns in the U. S. that have built reactors, have reactors on order or are prepared to accept orders for reactors.

U. S. industry has announced plans for the following electrical power reactors:

Organization and Plant Location	Electrical Power
Consolidated Edison (Indian Point, N.Y.)	275,000 KW
Commonwealth Edison (Joliet, Ill.)	180,000
General Electric & Pacific Gas and Electric (Pleasonton, Calif.)	5,000
Pennsylvania Power & Light (Eastern Pennsylvania)	150,000
New England Electric System (New England)	200,000
Carolinas-Virginia Nuclear Power Ass'n, Inc.	30,000
Pacific Gas & Electric Co.	Undetermined
West Penn Group	13,000
Florida Nuclear Power Group (West Central Florida)	130,000
Northern States Power Co.	66,000

Some of the above plants are now under construction. All are scheduled for completion by 1962. The total electrical capacity of the plants when completed will be less than one per cent of the estimated capacity of the country in 1962.

In addition a number of "power-research" reactors are in operation or are planned. These are used for design studies for power reactors.

The impact of atomic power in the propulsion and transportation fields is greatest at this time upon ship propulsion and sea transportation. The extent of the Navy program to convert combat vessels to atomic propulsion is not generally appreciated. The decision has been made to convert all fighting ships, both surface and submersible, to atomic power. The present Navy program involves thirty seagoing reactors plus six land based prototypes. All of these are to be operating by 1961. By 1966 the Navy plans call for forty reactors for carriers alone. These reactors will vary in capacity to deliver power from 1500 shaft horsepower to about 40,000 shaft horsepower. The larger vessels will be powered by several reactors.

The nuclear fleet built, building or authorized today consists of 19 submarines, one cruiser and one carrier. Five additional carriers, one a year through 1963, will be requested.

To date the Atomic Energy Commission has expended nearly 300 million dollars on the Navy program. The Navy has either spent or has planned through the 1958 program an expenditure of about one and a half billion dollars. It is estimated that the Navy atomic power program will be a 500 million dollar a year business by 1958.

Costs of atomic powered ships are high today but are slowly dropping. The cost of the atomic power plant has probably dropped to one half. The costs for fuel for the present atomic ships are about three times the cost of conventional fuels but this cost should be reduced in the future.

The first combination cargo and passenger vessel is now in the planning stage. This will be a demonstration vessel and will not be expected to compete economically with conventional ships.

It is likely that the first commercial vessels using atomic power will be large, high powered ships that carry heavy bulk cargoes of materials that are in unlimited supply. Such ships spend the maximum time at sea. Oil tankers and bulk ore carriers are examples of these commercial vessels. A modern tanker spends as much as ninety per cent of the time at sea. It may burn ten per cent of its pay load as fuel. It is estimated that an oil tanker of twenty thousand tons could earn about a million dollars a year additional revenue if it were powered by an atomic reactor. An English company has announced plans for an atomic powered tanker of 100,000 tons, and Japan has announced plans that a similar vessel of 75,000 tons will be built.

The total dollar value of the business which will come from placing atomic powered ships in service is impossible to estimate. Nearly all of the U. S. merchant fleet will become obsolescent between 1960 and 1965, that is, the ships will have been in service for twenty or more years. Some three thousand vessels are involved of which over three hundred are tankers. In any consideration of the economics of replacing these ships with atomic powered vessels, it must be remembered that the U. S. merchant marine is subsidized in order to maintain a reserve of shipping for war use. This fact may have a distinct effect upon decisions concerning the power plants of new vessels.

Hulls of atomic powered commercial ships would likely be constructed by the same shipbuilders as today.

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ATOMS, ELECTRONS AND PHOTONS

(Continued from Page 14)

The Navy program has enabled a number of firms to build competence in the ship reactor field. If all tankers over 1500 tons in the U. S. fleet were replaced by atomic powered vessels in the twenty years beginning in 1960 this would result in some one hundred and fifty million dollars per year of reactor business.

It appears that atomic power for railroad locomotives is feasible within the framework of the present technology. However, the economics of locomotives of this type are questionable.

Several programs designed to produce a useful atomic powered airplane are in effect. The project appears feasible and this may be accomplished within a few years. It is estimated that the development costs may be as high as a billion dollars. This cost is heavy but the advantages of a military airplane that could operate almost without limits imposed by fuel consumption would be many.

Once the required small and lightweight reactors have been worked out and the shielding problems solved useful atomic powered airplanes can be expected. It is difficult to estimate the number of such airplanes that would be desired but presumably a considerable amount of money will be spent in building this type of airplane once a prototype has been flown.

There are no foreseeable prospects for atomic powered motor vehicles.

Atomic power and radiation have had no great impact dollar wise on the chemical and drug industries to this date. However, these industries are very active in studying the new energy sources and there is every reason to believe that many applications will be discovered.

Unlike the power and utility and the transportation groups, the chemical and drug industries are most interested in the use of atomic radiation. Some drugs and surgical supplies that have been sterilized by radiation are now on the market. Plastics that are radiation treated are also for sale. Some plastics show a decided change in some of their physical properties after gamma ray irradiation. As an example, polyethylene plastic withstands heat much better after irradiation.

Raymond E. Vener of Catalytic Construction, before the Synthetic Chemical Manufacturers Association in September 1957, stated that in adding radiation to the three classical control elements of chemical reactions—heat, pressure and catalysis—we have a valuable tool for greatly extending the flexibility and utility of chemical processes.

Atomic Engery Commissioner, Willard F. Libby, before the UNESCO Conference in Paris in September 1957, stated that radioactive carbon and hydrogen could be used for chemical production control but are little used now, and isotopes in tagged drugs may become useful in medicine. The Geiger Counter may become a standard part of the doctor's equipment.

Although the application of radiation to chemical production is in its infancy, the Joint Congressional Committee on Atomic Energy estimates that in 1956 the use of radioisotopes saved thirty five million dollars through their use in refining and industrial tracing.

The chemical and drug industries are interestd in radiation as an energy source for the production and control of chemical reactions. They are also interested in the use of tagged atoms for research. The tagged atom is an atom that is made radioactive by exposure to neutrons in the atomic pile. The manner in which the tagged atom enters into chemical reactions can then be followed by use of the Geiger Counter. In industrial processes these atoms can be used to follow the progress of reactions, reaction rates, flow of materials and the like. Only a very few atoms need be made radioactive, due to the great sensitivity of radiation detecting instruments, and these applications therefore present no particular industrial hazard.

Atomic energy for catalyzing chemical reactions may be either gamma radiation or high energy electrons generated by an electron accelerating machine. The gamma radiation source may be either radioactive by-products of the atomic reactor or materials made radioactive by exposure to neutrons within a reactor.

As more power reactors go into operation there will be a very large amount of the by-product gamma radiation available. On the basis of present knowledge, it appears that the by-product radiation of a large power plant such as the Consolidated Edison plant planned for Indian Point, N. Y. will be capable of producing chemical reactions in several hundred tons of raw materials per day. A large amount of development work remains to be done. Not only must the effects of radiation upon chemical reactions be studied but facilities for handling the radioactive materials and for exposing the raw materials must be designed. These problems are under intensive study. Many uses of atomic radiation will certainly be discovered.

It has been demonstrated that radiation can change the structure of materials and even create materials which cannot be made by conventional means. The changes produced can be either destructive or desirable. Neutron radiation produces undesirable changes in transistors. Gamma radiation can produce changes in polyethylene plastic which enable the material to withstand higher temperatures. The electrical properties of some plastics are improved by exposure to gamma radiation. Irradiated plastics are now on the market. It is known that radiation can replace catalysts in the polymerization of plastics and can produce new types of graft polymerization.

Many U. S. producers of plastics and rubber are conducting research and development programs in the new technology. The Atomic Energy Commission's list of access permits carries the names of most of the large producers of rubber and plastics. Also the university and independent laboratories have a number of development programs. These organizations are publishing many papers in the open literature describing their work.

U. S. Rubber has announced the vulcanizing of experimental tires by use of gamma radiation. They have announced that they are also using high speed electrons in their studies. It appears that rubber vulcanized by radiation will have superior properties as compared with conventional rubber.

Radioactive isotopes are being used in the gauges that are required in production. There were 420 firms licensed to use such gauges in June 1957. It is estimated that their use produced twenty million dollars in savings last year. It is also estimated that the paper industry saved a like amount. The use of these gauges has only just begun and many additional uses will certainly be found.

The new technology has demanded new instruments of many types. Most, but not all, of these are electronic in character. Many types of instruments that have been used for years have been improved to make them useful for atomic applications.

The new instruments fall generally into the following groups.

Health and Safety—Instruments to measure the total exposure of workers to harmful radiation and to detect the presence of radioactive material upon the worker's body or clothing.

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ROCKY MT. ARSENAL FIREMAN DECORATED FOR RISKING OWN LIFE IN RESCUE OF CREWMAN FROM BURNING PLANE

General Creasy, Chief Chemical Officer, presenting Army's Exceptional Service Citation to Rocky Mountain Arsenal Assistant Fire Chief Dilly as Mrs. Dilly looks on.

On November 15, 1956, when an Air Force B-36 bomber crashed at the U.S. Army Chemical Corps' Rocky Mountain Arsenal, Denver, Colo., a member of the crew, Captain John O. Connell, Jr., was pinned in the nose of the burning plane. Risking his life, Assistant Fire Chief Theodore L. Dilly entered the burning fuselage amid exploding ammunition and the imminent possibility of explosion of fuel tanks and rescued the entrapped airman.

The Army's Exceptional Service Citation signed by Secretary Brucker was presented to Mr. Dilly by General William M. Creasy on December 19, 1957, in ceremonies in his office, Washington, D.C. Mr. Dilly's wife and Colonel R. L. Martin, C.O. of the Arsenal, and other officials of the Chemical Corps were present for the occasion.

Mr. Dilly, a firefighting specialist, has been employed continuously at the Arsenal since it was built in World War II, except during a period from 1944 to late in 1945 when he served in the Navy as a fire fighting instructor. He is the father of 7 children, ranging in age from 27 to 11 years. His eldest son, Theodore L. Jr., is staff sergeant in the United States Air Force.

CBR ATTACK BY INVISIBLE INVADER

By Major General William M. Creasy

(The following article by the Chief Chemical Officer of the Army is reprinted from the February 1958 issue of the "Army Information Digest," the official magazine of the Department of the Army. This Number of the Digest constituted Part II of a special issue in two Parts, commencing with the January Number, and presenting an estimate of the organization and development of the Army by the year 1962. Articles by the Chief of Staff and heads of principal Staff Divisions of the Department comprised Part I, and articles dealing with their respective services by each of the Chiefs of Technical Services made up the February issue as Part II.

The editor, in a foreword, noted that the year 1962 is far enough in the future to give reasonable assurance that presently planned changes within the Army will have been accomplished and far enough also to be beyond the scope of most current planning.

It is believed that A.F.C.A. members who have not seen the Army's Digest will be interested in reading General Creasy's contribution to this 1962 Army picture.)

The Army of 1962 will be the product of accelerated evolution; it will not suddenly emerge in being overnight; it is at least partially in being today.

Today, or in 1962, such an Army presents enormous new challenges to an enemy—even one with a vast reservoir of nuclear destructive power in his arsenal.

Consider the problem for a moment from a potential enemy's point of view. He finds himself confronted with an extremely formidable foe—a foe with good leadership, training, morale; with weapons certainly equal to his own, with vastly increased firepower—a foe hard to hit and pin down.

Thus confronted with tremendously reduced possibilities of a quick knockout in a head-on clash of forces, what alternatives remain for a determined potential enemy bent on conquest of United States forces in the field?

One of the alternatives could very well be chemical, biological or radiological (CBR) warfare.

Why should a potential enemy consider CBR warfare when thermonuclear weapons can achieve such vast destructive power?

The answer is not complicated.

Military attacks are not necessarily undertaken to destroy, but to occupy territory for which the occupier foresees a use.

World War II was the most costly and destructive conflict in history. More than 52 million people were killed or injured—more than half of them civilians. The belligerent nations spent more than a trillion dollars on armaments and war materials. The other material costs were immeasurable. And the world has seen how costly it has been to rebuild destroyed nations.

From this object lesson, we can see why CBR weapons may well appeal to an aggressor. The use of nuclear weapons on an indiscriminate basis would undoubtedly destroy facilities which were the object of an enemy's aggression, or at least render them worthless for postwar use. To make his aggression worthwhile, these highly coveted productive facilities would have to be reasonably intact at the end of hostilities.

To achieve this result, the enemy could use CBR munitions which would attack only people. By causing death or merely debilitating illnesses among industrial workers, their productive capacity would be lost or severely limited. And with this decrease in production, the Free World's armed forces would soon become seriously weakened through the lack of munitions, equipment, food, medical supplies.

In addition, it is quite conceivable that an enemy would consider the need for captive labor to man the factories he has captured intact. Nuclear munitions would kill or maim great numbers of people, rendering them of little use in the postwar economy.

But through the use of specific chemical, biological or radiological agents, the enemy might seek to make industrial personnel so ill that they could not work for long intervals of time during the period of combat—but leave them available as a manpower supply later on.

Minimum Destruction Agents

This is a most significant feature of CBR weapons. They are agents of minimum destruction—*i.e.*, in themselves they do not cause destruction of facilities, but instead attack the people who operate the facilities. Further, the degree of their effect upon people can be controlled. The advantages of this important fact to the plans of an aggressor can readily be seen.

But there is still another consideration which might be equally, if perhaps not more, tempting. This would be the fact that through the use of CBR warfare, an enemy's own losses might be considerably reduced.

The United States, it will be recalled, did not use this type of warfare in World War II. At the outset of that conflict, we announced that chemical warfare would be used only in retaliation for similar attacks upon ourselves.

But would a future aggressor gives us this advantage?

It would appear highly unlikely. Indeed, our potential enemies have already openly announced that their planning for the next war includes the possible use of CBR weapons.

There is still another military advantage-factor in the use of such weapons which might appeal to an aggressor nation—namely, their effectiveness. U.S. casualties in World War I showed that a man wounded by gas had a 14 times better chance of survival than did a man hit by flying lead or steel. An aggressor might well consider that this causes a drain upon manpower reserves since a non-fatal casualty needs five or six other people to care for him during the convalescent period, while a dead person is no such liability. The same reserve-depleting

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ARMED FORCES DAY

May 17, 1958

In accordance with Proclamation of President Eisenhower designating the third Saturday of May each year as ARMED FORCES DAY, appropriate ceremonies for the celebration of this day will be held throughout the nation and at overseas commands on May 17, 1958.

The establishment of a fixed day as Armed Forces Day for each year was provided for in the President's Proclamation for Armed Forces Day last year, which was signed by him on March 5, 1957. In addition to specifying the day, the Proclamation directs the Secretary of Defense on behalf of the Army, the Navy, and the Air Force, and the Secretary of the Treasury on behalf of the Coast Guard, to mark that day with appropriate ceremonies and to arrange for demonstrations and displays at armed forces installations. The directive further provides for inviting the participation by representatives of all religious faiths in such ceremonies.

The President, in the Proclamation, also invites the Governors of States, Territories and possessions of the United States to provide for the observance of the day each year.

Finally, The President calls upon his fellow citizens to display the flag of the United States on Armed Forces Day, in recognition of the sacrifice and devotion to duty of the members of the armed forces.

The slogan for the celebration this year, as in recent years, will be "Power For Peace."

For the purpose of planning and coordination of programs, including displays of armament and equipment, the country is divided into seven geographical areas, and area commanders for each have been designated as follows:

AREA I (Colorado, Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, South Dakota, Wisconsin, Wyoming)
Area Commander: Major General Robert E. L. Eaton, Commander, Tenth Air Force, Selfridge Air Force Base, Michigan
AREA II (Arkansas, Louisiana, New Mexico, Oklahoma, Texas)
Area Commander: Lieutenant General John H. Collier, Commanding General, Fourth U. S. Army, Fort Sam Houston, Texas
AREA III (Arizona, California, Idaho, Montana, Nevada, Oregon, Utah, Washington)
Area Commander: Lieutenant General Lemuel Mathewson, Commanding General, Sixth U. S. Army, Presidio of San Francisco, California
AREA IV (Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, Vermont)
Area Commander: Rear Admiral Milton E. Miles, Commandant, Third Naval District, 90 Church Street, New York 7, New York
AREA V (Delaware, Kentucky, Maryland, Ohio, Pennsylvania, Virginia, West Virginia)
Area Commander: General E. W. Rawlings, Commander, Air Materiel Command, Wright-Patterson Air Force Base, Ohio
AREA VI (Alabama, Florida, Georgia, Mississippi, North Carolina, South Carolina, Tennessee)
Area Commander: Rear Admiral George C. Crawford, Commandant, Sixth Naval District, U. S. Naval Base, Charleston, South Carolina
AREA VII (District of Columbia and neighboring areas of Maryland and Virginia within the Military District of Washington)
Area Commander: Major General Reuben C. Hood, Commander, Headquarters Command, USAF, Bolling Air Force Base, Washington 25, D. C.

Commanders for overseas commands have been designated as indicated below:

ALASKAN COMMAND: Lieutenant General Frank A. Armstrong, Jr., USAF, Commander-in-Chief, Alaskan Command, APO 942, Seattle, Washington
CARIBBEAN COMMAND: Lieutenant General Robert M. Montague, USA, Commander-in-Chief, Caribbean Command, APO 834, New Orleans, Louisiana
EUROPEAN COMMAND: General Lauris Norstad, USAF, Commander-in-Chief, European Command, APO 128, New York, New York
PACIFIC COMMAND: Admiral Felix B. Stump, USN, Commander-in-Chief, Pacific Command, FPO, San Francisco, California

CBR ATTACK

(Continued from Page 18)

effect could be achieved whether chemical, biological, or radiological agents were employed.

One final—and vastly important—advantage-factor in the use of CBR warfare which might appeal to an aggressor nation or bloc is the fact that the utilization of various agents in this field permits the covering of large areas to military advantage with a minimum of logistical effort. This means greatly reduced expenditures of material and industrial resources.

Specifically, what are some of the CBR agents which might be employed by an enemy—today or in 1962? A look at the chemical weapons now available will make clear the potential in this field five years hence.

Those who know nothing about the war gases, or have only a smattering of misinformation about them, think of them as strangling, pain-producing horrors.

But actually, among the most painful of the war gases are those which are used for harassing effect and which do not cause actual battle casualties. An example would be tear gas, which is employed for riot control. Its effects—crying, coughing, skin prickles—are quite irritating for a while, but pass off within an hour or so.

Of the real casualty-producing agents, the three principal types are the vesicants or skin-burning agents, the lung irritants, and systemic poisons. Mustard gas is a vesicant, while phosgene is an example of a lung irritant.

Newest of the systemic poisons are the nerve gases. They are colorless, odorless, and much more lethal than any other war gas yet perfected. They were discovered by the Germans during World War II, in the course of research designed to develop improved insecticides. The *Wehrmacht* had quantities of nerve gas stored and ready for use during that war.

Indeed, considering the advances already made, science fiction descriptions of nerve gases, paralyzing gasses, and gases that affect the minds of men, could well be closer to the realm of fact than fiction in the course of the next five years.

These, then, are some of the threats to be considered in the field of chemical warfare. Similar hazards exist is the areas of biological and radiological attack.

Biological agents may be used to produce death, disease or debility among men, animals, or growing plants. Such agents are classified into three groups: living organisms; toxins, which are toxic substances derived from living organisms; and crop agents, including chemicals which might be used as crop poisons.

Among the harmful types of living organisms are many of the form commonly called bacteria and viruses. Many different types and forms of these micro-organisms might be used against man, animals, or plants.

Toxins are powerful poisons produced by the life processes of various living organisms. Some micro-organisms, like diphtheria, produce toxins within the body of the victim or "host." The poisons may also be generated in some other environment and later taken into the body, as in the case of food poisoning.

Crop agents are either micro-organisms which attack vegetation, or chemicals which retard the growth of a plant or desrtoy its life. Although such use of chemicals might rather be classified as a part of chemical warfare, the nature of the action and its uses has placed it in the biological warfare field.

The kind of agent which might be used in biological warfare would depend on what the enemy hoped to get out of an attack. If he wanted to kill large numbers of people, he would have a number of pathogens from which he could choose. But an attacker might only want to make people sick, rather than kill them. For this purpose, other agents might be used.

Biological warfare agents also could be used to attack the animals upon which man depends for food and clothing; and many kinds of plant disease-producing agents could be used to attack his food crops. Disease could damage grains, fruits, green vegetables.

The very nature of biological warfare gives an aggressor nation great flexibility in methods of delivery. Effective employment is possible by means ranging from use by saboteurs against selected installations to mass delivery over large areas by airplanes, submarines and missiles.

Third, and by no means the least, of the CBR threats is that of radiological attack.

Radiological warfare is the attack on personnel by means of radioactive agents. This may be the result of fallout caused by the burst of a nuclear weapon, or it may result from distribution of radioactive material by other means, such as by small bombs dropped from planes or missiles. With the latter system there would be little or no attendant destruction of facilities.

With this type of warfare, an enemy could cause short- or long-term contamination and denial of large areas, depending on the means of contamination and the material employed. And a similar control could be exercised in regard to troops and population in those areas—whether to kill or merely incapacitate.

Methods of Defense

It is true, of course, that advances have been and are being made in methods and techniques of defense against attack by chemical, biological, radiological means.

Let us consider for a moment these advances as they might apply in 1962 if an attack were made against a large industrial city.

Our assumptions also include the fact that, because of its strategic value, the city is under long-range attack by the enemy in order to cut down on its war material production. The enemy, however, recognizes a foreseeable need for the plants and factories in the post-war period and so is attempting to neutralize the production effort by using non-destructive weapons in the CBR field whenever and wherever it is practicable to do so.

We must assume that this hypothetical city has a good civil defense system in which the populace takes an active part; that adequate protective equipment for defense against CBR weapons has been developed, procured, and distributed: and that full use is made of that equipment. Much of that equipment will have been developed by the U.S. Army Chemical Corps and adapted to civil defense use.

The first problem of residents of this city of 1962 will be to know whether the enemy has staged a chemical or biological attack. This is not simple, since CBR, or toxicological, agents are not easily detected by the human senses.

For chemical attack, the threatened city will have automatic alarms which will give a visible or audible signal when the mechanism detects minute quantities of agent in the air.

To identify the type of agent being used, the city will have identification sets which can be simply operated by personnel with a minimum of special training.

For detection of biological attack the city will have devices which can count miscroscopic, airborne moisture particles, germs, or dust, with amazing speed. By indicating the presence of unduly large amounts of foreign matter in the air, they can alert the city that an attack

may be under way. Rapid means of identifying germs will be available.

In the radiological field, the attacked city will employ a new type of dosimeter which detects and measures the amount of radiation to which a person may have been exposed.

Those are some of the means which residents of the target city would use to detect and warn them that they have been subjected to an enemy chemical, biological, or radiological attack.

However, detection and identification would be of little use without means of protection.

Community Protection

Protection of a community falls into three categories: individual, family, collective protection.

The primary means of individual protection is the protective mask. This inexpensive, lightweight, pocket-size item has been developed to the point where it not only protects against chemical vapors, but also protects a person from breathing in bacteria or radiological dust.

Such a mask will protect a person from breathing contaminated air, but since some agents attack the body through the skin, the city must also have a supply of impermeable clothing for protection of those who must perform missions within contaminated areas.

For family protection, an important aid will be "diffusion board," a gas-aerosol filter material resembling ordinary wallboard but so made that air can pass through it quite freely. This fiberboard has excellent gas-arresting properties. In small shelters, it operates almost as efficiently and effectively as a forced-flow type of filter. It also filters out biological agents and atomic or radioactive dust. In the target city, family-type bomb shelters would be lined with it.

The city's public bomb shelter program includes use of large mechanical collective protectors in shelters that have been, or can be made, reasonably air-tight. Their basic operating principle is the same as that of a protective mask, except that the air is forced through the filters by motor.

The city also is presumed to have an adequate supply of infant protectors—rectangular boxes consisting, in part, of the gas-aerosol filter material, semi-clear plastic for vision, and a rigid bottom to support the child.

For nerve gas victims, the city is prepared with atropine syrettes, and its rescue workers are trained in the back-pressure arm-lift method of artificial respiration. If atropine can be injected into the victim within 30 seconds after the first symptoms appear, it will help counteract the action of the gas. These syrettes are a part of the standard military equipment, as is the protective mask. The new method of artificial respiration has been made standard, too, because it induces more fresh air into the lungs and is more efficient than the old method.

Besides the physical means of protection against biological warfare agents, the city also has the benefit of numerous important advances in the bio-medical field, including disease-preventing vaccines, and a means of giving multi-immunizations with one injection, to replace the old method of giving numerous shots for various diseases.

By employing these and other methods, the city could effect a great reduction in casualties from toxicological attack. These actions must, of course, be taken with full cognizance of the fact that the enemy may choose to use nuclear weapons alone or in conjunction with toxicological attacks. Thus the means of defense employed against these agents, as described here, must be in addition to such measures as digging in for protection against blast, thermal and radiation effects of nuclear weapons.

TO STUDY ASIAN FLU EPIDEMIC DATA

(General Creasy, addressing Compressed Gas Association, states information obtained may aid in estimating results which might be expected from a widespread BW attack—Views CBR means as complementary to but not in competition with atomic weapons.)

Studies of data pertaining to the Asian flu epidemic for their possible value in estimating effects to be expected from a widespread biological warfare attack are to be made by government agencies. Major General William M. Creasy, Chief Chemical Officer of the Army, stated in addressing the Compressed Gas Association at the Waldorf-Astoria Hotel, New York, N.Y., on January 20, 1958.

General Creasy' address was entitled "Should We Worry About Chemical and Biological Warfare?"

The address dealt with all three forms of toxic warfare. The references to Asian flu were contained in discussion of biological warfare, quoted here, in part:

"Biological warfare is the deliberate use by man of microorganisms (germs) to cause disease and possibly death among humans, animals, and plants. By his choice of a disease-agent, the initiator of a biological warfare attack could decide beforehand the results he wanted to achieve; death to humans; incapacitation of people for long or short periods; or destruction of man's food supply in the form of livestock or crops.

"There are a great many disease agents from which an enemy could make his selection for a specified military purpose. He might choose an acutely debilitating agent, a chronic disease-producer or one causing a high rate of lethality. It is entirely possible that certain mutational forms may be produced which have strong resistance to drugs, or in forms which make identification difficult. However, I should like to emphasize that it is not likely that entirely new agents of unique virulence or new disease-producing capacity may be produced, even though the world has made remarkable genetic progress in producing bacterial transformation in recent years.

"Since time began man has been on the defense against disease spread by natural means. Just recently we have witnessed the rapid spread of Asian Flu throughout many parts of the world. Fifteen to twenty million people have been affected. Incidentally, in cooperation with other agencies of the government, a study is being made of the effects of the Asian Flu epidemic on the nation's defense resources. The epidemic will be studied as though it simulated a biological warfare attack. Data will be collected on the effect of the disease on community functions and their relationship to industrial production including their ability to carry out assigned missions under epidemic conditions. Information as to the ability of military units to carry on their work under such conditions also will be studied.

"The epidemic has given us a rare opportunity to collect data which could be of utmost importance in estimating the extent of damage which might be expected from a widespread biological warfare attack. . . .

"The biological agents can be distributed by an enemy saboteur with comparative ease . . . He could pack all the apparatus needed in one suitcase.

"We also must be concerned with the possibility of overt military delivery of biological agents . . . The same delivery vehicles—aircraft, submarine or guided missiles could be used. If it is possible for an enemy to drop an atomic bomb on a city, it should be equally possible to disseminate a cloud of biological agent over that city."

Continuing, General Creasy said:

"The development of means of defense against CBR munitions is an important phase of the work of the Army Chemical Corps. As a companion to defense, we, of course, are most intimately concerned with the development of means for the direct use of these weapons should an enemy decide to use them first. We work closely with the Federal Civil Defense Administration in the adaptation to civil defense use of ideas and items . . . for the protection of troops.

"Recent developments include methods for detecting the presence of nerve gases in the air. We also have developed the means for the rapid detection and identification of disease germs. We have developed material for use in masks and shelters to filter out air contaminated by chemical agents, germs, and radioactive dust . . . There are many other developments, either completed or in progress . . . We are constantly working on the problem of immunization against diseases that might be used in biological warfare attack. There is a great deal more to be done.

"I cannot stress too strongly the necessity for full public recognition of the fact that the hazards in the field of biological, chemical, and radiological warfare, can be as great and as far-reaching in their effects upon our ability to survive and defend ourselves, as those in atomic warfare. The CBR weapons do not compete with the atomic weapons but they are a natural complement to them in that they have great power to extend casualties and to break down a peoples' will to fight. . . ."

ATOMS, ELECTRONS AND PHOTONS

(Continued from Page 16)

Monitoring—Instruments that monitor areas, materials, air and gases, water and tools and equipment for the presence of radiation. Such monitoring is required for protection of workers, communities and in some cases for reactor control.

Reactor Control—Instruments to measure intensity of neutron and gamma radiation for reactor control. Also, instruments of new design to sense temperature, pressure and flow rates. These instruments must respond in very short periods of time. Many instruments of this type must operate while exposed to intensity gamma and/or neutron radiation. Their reliability must be of a high order.

Irradiation Control—the use of gamma and energetic electron radiation in research and production requires control instruments of new types. Such instruments are necessary for the protection of workers and also for determining the amount of radiation absorbed by materials being irradiated. This latter problem is difficult and is the subject of much development at the present time.

Remote Control—The protection of workers often requires that materials be handled by remote control. Radioactive materials are often manipulated while behind heavy gamma ray shields. Spent fuel rods in nuclear reactors are highly radioactive yet must be removed from the reactor and replaced by fresh rods. The spent rods are allowed to "cool off" behind a shield, often water, for a time before being processed for the removal of poisoning materials and the reclaiming of uranium. These rods during the cooling period are often used as sources of gamma radiation and must be remotely positioned and the material to be irradiated must be brought into position by remote control. Remote control of materials undergoing irradiation by electron machines is also required.

There is considerable activity in developing and manufacturing special instruments and devices required by the new technology. There are probably more U. S. firms engaged in this work than in any other field of atomic development. In general these are small firms and the annual dollar value of the business of any one firm is not large but the national total is a respectable sum. As an indication of the activity, one recent issue of the magazine *Nucleonics* carried the advertisements of thirty-three firms that offered radiation measuring and atomic control instruments for sale. University and government laboratories are active in the development and improvement of such instruments and equipment.

The U. S. Army Quartermaster has sponsored a large research study of the preservation of food by radiation for the past several years. Some fifty commercial, university and government laboratories have taken part in this program.

The Quartermaster program has been extensive for several years. The work has progressed to the point that soldier volunteers have been fed radiation preserved food. At the recent Atomic Trade Fair in New York (Oct. 1957) an exhibitor showed foods ranging from steaks to potatoes and muffins all preserved by radiation.

Experimental work to date has shown conclusively that radiation can kill all living spoilage organisms provided only that sufficient radiation is applied. It has also been clearly shown that sprouting can be controlled in potatoes and onions by quite modest amounts of radiation. Infestation of cereal grains and cereal products can be controlled by low level radiation. Trichina in pork can be controlled by small amounts of radiation.

The table below lists the approximate amounts of radiation required.

	Radiation (in ratiation units)
Sterilization of Meat, Fowl, Fish, Fresh Vegetables	2,000,000
Pasteurization of Food	200,000
Destruction of Insects	30,000
Destruction of Parasites	30,000
Control of Sprouting	12,000

There is no evidence that preservation by radiation imparts toxicity to the food. Swift and Company have used some three thousand experimental animals covering a span of three generations in their experiments without observing any toxic effects. Other laboratories have fed additional thousands of animals without observing signs of food toxicity. There is some loss of vitamins but this is less than the loss in conventional canning. As mentioned above, the Army Quartermaster has conducted limited tests with humans without observing any reactions due to toxicity. The Quartermaster is now expanding his tests to Army company sized units.

The fact that it is demonstrated that irradiated food is wholesome does not necessarily indicate public acceptance. Sterilizing amounts of radiation produce undesirable color, odor and taste changes in some foods. Examples are beeksteak, green beans, hamburger, veal, butter and milk. Many food withstand sterilizing with little or no change. Among these are bacon, codfish, corned beef, pork, prunes, sardines, and chickens.

It appears that all foods will withstand sufficient radiation for pasteurization without harmful change. In the pasteurizing process food is packaged to exclude airborne micro-organisms and exposed to about 200,000 units of radiation. This does not preserve in the sense that canning preserves but does extend the shelf life, with conventional handling, from five to ten times. This treatment sterilizes the surface of the food and increases the time for the appearance of surface slimes on meat and molds and rotting in fresh fruits and vegetables.

Either gamma radiation or energetic electrons as generated by the electron machines may be used in treatment of foods. The electrons do not have great penetrating power and would be of limited usefulness in treating hams or other thick cuts of meat. These machines would be useful in treating flour or grains or in the surface treatment of pre-packaged fresh fruits and vegetables and meats. A medium sized machine has the capacity to treat about twenty tons of grain or flour per hour to prevent infestation and about forty tons of potatoes or onions per hour to prevent sprouting. It is estimated that this type of treatment will cost a fraction of a cent per pound.

No pilot plant work has been done in studying the economics of preserving food. It is estimated that costs

will run from three-tenths to seven cents per pound depending upon the amount of radiation required and the type of packaging required. These costs can be compared with freezing costs of about seven cents per pound and canning costs which run from a half to five cents per pound.

It is interesting to estimate the food preserving capability represented by the radiation from the radioactive by-products of the nuclear reactor. As mentioned above, a reactor designed to produce 100,000 KW of electric power is planned for Monroe, Michigan. The radiation from the by-products of this reactor should be capable of sterilizing about five hundred tons of meat per hour assuming one hundred per cent utilization of the radiation.

The research work is essentially completed for the treatment of potatoes, onions, cereals and cereal products and to destroy trichina in pork. There should be no serious problems in the design of the required plants. It is estimated that from three to five years will be required to complete the necessary work for the study of sterilization of those foods which lend themselves most readily to this process. More time will be required for those foods which show color and taste changes.

Plants for radiation processing of foods will require fairly heavy capital investments as compared to present costs. At least this will be true for fresh fruits and vegetables. It is likely that the first such plants will be placed near power reactors and in an area where food is produced in large quantities. The first use of radiation will probably be for the treatment of potatoes and onions and cereals and cereal products. The first treatment of fresh meat, fish, vegetables and fruit will probably be the pasteurization treatment. Commercial sterilization will come later and follow experience gained in the pasteurization of food.

It has been estimated that in the period of 1957 to 1975 the business of designing and fabricating reactors and associated equipment and necessary facilities will amount to twenty-six billion dollars. Also it is estimated that one-fourth of this represents the cost of highly specialized equipment, one-fourth the cost of rather conventional equipment such as turbines, generators, valves and piping and the remainder represents the cost of engineering and construction of a quite conventional type. The reactor business is opening entire new fields of technology. As would be expected, many firms are specializing within these various fields.

As an indication of the scale of expansion of the new industry, there were nearly 24,000 persons employed on nuclear construction alone in September 1957. This figure includes the workers engaged in both government and private projects.

The AEC reported the distribution of access permits for access to classified information among individuals and organizations according to fields of interest as of June 30, 1957, as follows:

Field of Interest	No. of Permits
Operating Atomic Facilities	
Recators for Electric Power	162
Reactors for Research, Ship Propulsion, etc.	59
Chemical Plants for Fuel Processing	64
Manufacture of Atomic Energy Products	
Reactors	90
Components	287
Materials for Atomic Application	149
Related Activities	
Use of Radioisotopes	64
Design & Construction, Facilities	98
Others, Not Classified Elsewhere	65

The above list is not complete and lists only fields of interest with the larger number of permits.

The design and fabrication of atomic reactors of various types and the production of the required associated equipment and instruments are opening new fields for U. S. industry. The production of new raw materials such as uranium and other metals has given rise to several new industries. This new business now amounts to several billion dollars annually and will grow. Several hundred U. S. industrial firms are now prepared to produce the new materials and have developed the required engineering experience and the new fabrication techniques, As reactor technology advances, industry will constantly be required to expand its skills in these new fields. It is not likely that the ultimate types of reactors have yet been designed. One may certainly expect rapid changes in reactor engineering as experience is gained in the operation of the larger reactors.

The industrial expansion due to the design, fabrication and use of atomic reactors is by no means the entire expansion of industry due to the atomic age. Many types of business that have no direct interest in atomic reactors or reactor generated power are, nevertheless, influenced by new materials, new techniques and new radiation sources. The industrial use of radiation in various forms and in many applications is growing rapidly. Below are listed a number of activities in which the new technology is being used.

Chemical Reactions, Research and Production
Chemical Process Control
Gauges, Thickness and Density, High Speed Applications
Flow Rates, Measurement and Control
Corrosion, Determination and Measurement
Wear Studies
Plastics, New Properties by Irradiation
Rubber Vulcanization
Radiography, Inspection and Quality Control
Height of Fill, Containers
Oil Well, Logging and Stimulation
Plant Breeding
Medicine, Diagnosis and Treatment
Luminescent Materials, Signs, Lamps
Ionization Sources
Batteries
Leak Detection
Drugs, Sterilization
Food Preservation
Insect Control

An analysis of the various industrial organizations in the U. S. using isotopes in 1956 gives an estimate of the widespread adoption of new techniques. The analysis is given below:

Use	Number of Organizations Using
Gauging	420
Radiographic Inspection	350
Radiation Effects	88
Luminescent Materials	49
Ionization Sources	44
Wear Studies	38
Leak Detection	24
Catalytic Studies	16
Radioactive Batteries	13

The use of radiation in special gauges is growing rapidly. Such gauges use small radioactive sources. The radiation is allowed to pass through the material being gauged and to enter a radiation measuring instrument. The amount of radiation reaching the instrument depends upon the thickness of the material being gauged and its density. A cigarette gauge will instantly detect loosely packed tobacco and a metal sheet gauge will detect slight variations in sheet thickness. These gauges not only improve quality control but allow the fabricat-

ing machinery to run at higher speeds. The introduction of this type of gauge allows paper making machinery to be run at twenty per cent greater speed.

Estimates were presented before the February 1957 hearing of the Joint Congressional Committee on Atomic Energy to show that nearly 500 million dollars were saved in 1956 by the industrial application of radioisotopes.

It is estimated that the market for gauges which use radioactive materials is less than ten per cent saturated. At the end of 1956 the Atomic Energy Commission had licensed 3,375 such gauges. Today about 500 firms are using isotopes for radiography. Nearly a million persons annually receive medical treatment in which radiation is used. Batteries powered by radioactive materials have been developed. Watches which use these batteries have been announced. Signal lamps which are atomic powered and which have life times measured in years are available.

In addition to the above, conventional manufacturing will certainly find uses for the new fabrication techniques and the new materials developed by atomic reactor requirements. The impact, measured in dollars, of the new atomic technology upon the whole of U. S. business is not large at the present time but is growing and should continue to grow at an accelerated rate.

There are several forces at work which tend to increase the demand for more highly skilled and better trained technicians, engineers and scientists and which also increase the demand for all types of scientific and technical skills. Among these forces are the following:

Increase in population.
Increase in standard of living.
Use of technical personnel in defense activities.
Introduction of automation into industry.
Development of the technology for the peaceful use of the atom.
Increasing use of technical personnel in management jobs.

The Atomic Industrial Forum, Inc. estimates the need for professionally trained people in the atomic energy field as follows.

Year	AEC	Required Industry	Total
1958	15,000	4,500	19,500
1964	15,000	15-25,000	30-40,000

If these numbers of people are to be found. about six per cent of all the college graduates in the years indicated will have to enter the atomic field. If this goal is to be met there must be an intensified effort to train college students in the new techniques.

Non-professional people with a wide range of highly developed specialities must also be found. The demand will largely be met by re-training skilled workmen. As an example, when the K-100 reactor was started up by General Electric the following types of non-professional people were required.

Operations Supervisors	Chief Operators
Pile Operators	Utility Operators
Control Operators	Power Operators
Craft Foremen	Craftsmen
Instrument Craftsmen	Radiation Monitors

General Electric was fortunate in this instance since key personnel, both professional and non-professional, could be transferred from reactors that the company was operating. However, even these experienced people had to have some additional training on the new reactor. General Electric estimates that the total costs of training for operation of the K-100 reactor was over a million dollars. This figure includes salaries during the training period.

During the construction of the Savannah River project DuPont found it necessary to train many welders in special techniques. During 1952 a total of 2,665 men were trained. At Hansford, Washington, heliarc welders were needed for the construction of the Purex facility. Seven hundred men were trained at a cost of four hundred and eighty-five thousand dollars.

Engineers and technicians of all types need special training to meet the unusual requirements of atomic work. Development has now reached the point that requirements for skilled technicians and engineers with special training probably exceeds the need for scientists. The construction, operation and maintenance of atomic plants require personnel with above average qualifications.

Craftsmen and operators must have higher and more diversified skills. As an example, a real appreciation of the high pressures and temperatures involved and the radiation danger is necessary. Craftsmen must develop skills for working many new metals such as uranium, beryllium, zirconium and thorium. The use of radiation shielding must be generally understood. Many workers must understand the use of radiation instruments and the general health physics requirements for their protection.

It is clear that large numbers of professional and nonprofessional people with new skills and training are required. People must develop quite different attitudes toward problems of safety and must understand the use of new instruments for health protection and control of power and radiation. Most areas of the country do not have sufficient trained people for the atomic work in sight. One of the large problems in industrial expansion of the atomic technology is the assuring of properly trained people in sufficient numbers.

INFORMATION SOURCES

There are many sources of information concerning the industrial uses of atomic energy. The sources listed have been consulted in preparing this paper.

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Annual Reviews of Physical Chemistry

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CHAPTERS IN CHEMICAL WARFARE

III

CHEMICAL WARFARE IN THE CIVIL WAR

By Wyndham D. Miles
U. S. Army Chemical Corps Historical Office

New Haven Conn. June 22. 1864.

President Lincoln,

Respected, & honored Sir:

I find that by mingling strong sulphuric acid with strong hydrochloric or Muriatic acid on a broad surface like a shovel or shallow pan a dense white cloud is at once formed, and being slightly heavier than the atmosphere rests upon the ground and is high enough to conceal the operator behind it. This may easily be continued by additional sprinklings of the two acids and a light breeze will waft it onward. When the cloud strikes a man it sets him to coughing, sneezing &c. but does not kill him, while it would effectually prevent him from firing a gun, or if he should fire, to aim at his object. It has occurred to me that Gen. Burnside with his colored troops might on a dark night, with a gentle breeze favorable, surprise and capture the strong holds, of Petersburg, or Fort Darling, perhaps, without loss or shedding of blood. I trust your Excellency will excuse the liberty of a son of Revolutionary Soldier well known to Hon. Sec. Chase Prof. Silliman & Gov. Buckingham and has the honor to be personally & politically

Yours,
Forrest Shepherd.
Economic Geologist
New Haven
Conn.

His Excellency
Abraham Lincoln

Letter from Forrest Shepherd of New Haven, Connecticut, to President Lincoln, explaining Shepherd's idea for chemical warfare.

"PRESIDENT LINCOLN," the letter read, "Respected and Honored Sir: I find that by mingling strong sulphuric acid with strong hydrochloric, or muriatic acid on a broad surface like a shovel or shallow pan, a dense white cloud is at once formed, and being slightly heavier than the atmosphere, rests upon the ground and is high enough to conceal the operator behind it. This may easily be continued by additional sprinkling of the two acids and a light breeze will waft it onward. When the cloud strikes a man it sets him to coughing, sneezing, etc., but does not kill him, while it would effectually prevent him from firing a gun, or if he should fire, to aim at his object. It has occurred to me that Gen. Burnside, with his colored troops might, on a dark night, with a gentle breeze favorable, surprise and capture the strongholds of Petersburg, or Fort Darling, perhaps without loss or shedding of blood. I trust Your Excellency will excuse the liberty of a son of a Revolutionary soldier, well known to Hon. Secretary Chase, Prof. Silliman and Gov. Buckingham, and has the honor to be personally and politically yours."

This letter, sent by Forrest Shepherd of New Haven to Abraham Lincoln, contained one of several suggestions regarding chemical warfare made during the Civil War. Other Americans mailed ideas on the subject to the War Department, incorporated them into magazine articles, or, lacking confidence, bandied them about in conversation. However, no one seems to have taken chemical warfare seriously, and the ideas were forgotten as soon as the war ended. Shepherd's letter was filed away and gathered dust for seventy years until it was uncovered in the National Archives and given some publicity.

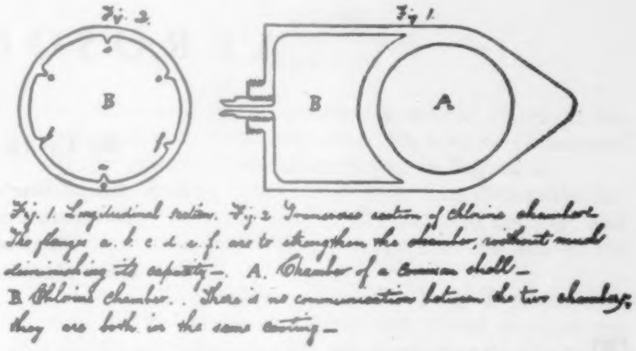
Today, with chemical warfare a reality, we are interested in the old views. They are not easy to find among the mountains of documents left from the period, but occasionally someone researching in the National Archives, or reading the literature of the period, comes across one. Thus through serendipity we have come to learn something of the inventiveness that our great-grandfathers demonstrated in proposing chemicals as weapons.

The chemistry involved in Shepherd's idea was simple. The heat generated by the mixing of the acids would vaporize some of the hydrochloric acid in the form of a mist. It would have been quite a trick to send this mist rolling across no-man's-land into the Confederate entrenchments at Petersburg, but if it could have been done, the Confederates would have been in a turmoil. While hydrochloric acid fumes are not poisonous in the same sense as chlorine, phosgene and other agents, they sting the nostrils, throat and eyes. Lee's soldiers could have done nothing but flee.

Forrest Shepherd was a well-known consulting geologist. He made his home in New Haven, but spent much of his time tramping through regions of North America on geological and geographical explorations. California, Northern Mexico, New Brunswick, Newfoundland, the islands in the Bay of Fundy, the copper and iron mines of the southern shore of Lake Superior, the mineral lands between Hudson Bay and Lake Superior, all came under his eye. Between 1847 and 1856 he was also Professor of Economic Geology and Agricultural Chemistry at Western Reserve. His knowledge of chemistry descended from Benjamin Silliman, Yale's famous professor. Born in New Hampshire in 1800, he died in Connecticut in 1888.

In Shepherd's plan the would would propel the acid mist to the southern lines. This is the method that was relied upon half a century later for the first gas attack of World War I. John Doughty (a man whom, unfortunately, we know nothing about) of New York City came up with a different idea. He thought that a hollow artillery shell might do the trick.

On April 5, 1862, Doughty sent a letter to the War Department suggesting that shells filled with chlorine be shot at the Confederates. Doughty was not taking any chances that the officials in Washington would misunderstand him, so he sent along an adequate description of the gas, its effects, and his shell:



John Doughty's plans for a chlorine shell, submitted to the War Department, April 5, 1862.

"The above is a representation of a projectile which I have devised to be used as a means for routing an entrenched enemy. Believing it to be new and valuable, I send the War Department a brief description: Chlorine is a gas so irritating in its effects upon the respiratory organs, that a small quantity diffused in the atmosphere, produces incessant & uncontrollably violent coughing.—It is 2½ times heavier than the atmosphere, and when subjected to a pressure of 60 pounds to the inch, it is condensed into a liquid, its volume being reduced many hundred times. A shell holding two or three quarts, would therefore contain many cubic feet of the gas.

"If the shell should explode over the heads of the enemy, the gas would, by its great specific gravity, rapidly fall to the ground: the men could not dodge it, and their first intimation of its presence would be by its inhalation, which would most effectually disqualify every man for service that was within the circle of its influence; rendering the disarming and capturing of them as certain as though both their legs were broken.

"To silence an enemy's guns or drive him from his entrenchments, it would be only necessary to explode the shells over his head or on his windward side. If exploded in rapid succession over, or within a fort, evacuation or surrender could not be delayed beyond fifteen minutes. Casements and bomb-proofs would not protect the men.

"This kind of shell would, I think, in the present advanced state of military engineering, be a very efficient means for warding off the attacks of iron-clad vessels and steam rams; for, as to the steam ram, a ten inch gun that would carry a shell containing a gallon or two of the liquid, would with ordinary accuracy, be able at the distance of ¾ of a mile, to envelop him in an atmosphere that would cause his inmates to be more anxious about their own safety than about the destruction of their enemy.

"It may be asked if the gas which drove the enemy from his guns, would not prevent the attacking party who used the gas from taking possession of the abandoned position. I answer it would not: for, this shell does not, like the Chinese stink-pots, deposit a material emitting a deleterious gas lighter than the atmosphere, but suddenly projects into the air, a free gas much heavier than the atmosphere, which does its work as it descends to the earth, where it is soon, absorbed.

(Continued on Page 33)

SCIENCE AND TECHNOLOGY DEPARTMENT

SOME ASPECTS OF PARTICLE SIZE IN AEROSOL STUDIES

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The air about us contains billions upon billions of small particles of every description and composition. Many of these particles arise from dry areas by the wind and evaporation of sprays from the oceans. Many other particles in the air are the products of man's activities. Particles arise from the exhausts of cars and busses, your neighbor's incinerator, industrial plants, atomic tests, etc. Some of these particles are toxic, but most are non-toxic.

In rural areas, the concentration of particles in the air that is detectable by the microscope exeeds 1,000,000 per liter. If the range is extended by the ultramicroscope, the count is increased by as much as twenty-fold.

In industrial areas, the concentration is generally greater by at least another factor of ten.

Man, under normal activity, inhales about 15 liters of air per minute. Suppose, on the average, the particles he inhales have an average size of 0.5 microns, and the density is that of water. In a lifetime of, say, 70 years, in air containing the equivalent of 100,000 particles, 0.5 microns in size (per liter), he would inhale about 5 to 6 grams, and only a portion of these particles would be retained in the respiratory tree. This illustrates one important aspect of atmospheric particles; the very low mass concentration.

The term aerosol includes all aero-suspensions of solid or liquid particles with a diameter less than 50 microns. The usual range of particles is from 0.1 to 10 microns, although particles as small as 0.01 microns may be encountered. A red blood cell is about 7 microns in diameter. Natural aerosols include smokes, dust, fog, and haze. Artificial aerosols are becoming increasingly important today as is evident by the wide use of insecticides.

The range of particle sizes in the various types of aerosols is considerable. Dust may range from fine particles of 0.1 microns or less, which produce a haze, to sand storms having large particles beyond the range considered to be aerosols. Smoke screening particles should be about 0.3 microns for maximum effect. Water droplets (fog) are much larger, ranging in size from 4 to 40 microns.

The stability of an aerosol is determined by a number of factors. The individual particles may move about under the influence of several different forces: (1) *Brownian movement*, which consists of random oscillations and rotations causing coagulation, accompanied by drift which results in diffusion to any solid object, such as the walls of a container or the ground; (2) *Settling*, under gravity; (3) *Thermal forces*, causing movement of the particles toward any object colder than its surroundings; (4) *Electrical forces;* (5) *Acoustical forces;* and (6) *Centrifugal forces*. 0.1 micron particles require centrifugal acceleration of 1,000,000 times gravity to precipitate.

In addition, *convection currents* produce motion of large or small regions of the aerosol relative to other regions.

Finally, there may be *evaporation* causing particles to decrease in size and even disappear, and *condensation* which may cause the particles to increase in size until they fall out very rapidly.

TABLE 1

Rate of fall of particles in air
(Unit density, 1 atm., & 20°C)

Diameter	Weight	Terminal Velocity
m/u	mmg.	cm/min.
0.2	4.2×10^{-9}	0.014
0.5	6.5×10^{-8}	.06
1	5.2×10^{-7}	.21
2	4.2×10^{-6}	.77
3	1.4×10^{-5}	1.6
5	6.5×10^{-5}	4.7
10	5.2×10^{-4}	18
20	4.2×10^{-3}	72
30	1.4×10^{-2}	162
51	6.5×10^{-2}	432
100	5.2×10^{-1}	1,500
200	4.2	4,200
300	14	6,900
500	65	12,000
1000	525	23,100

UNDER ordinary conditions, the stability of an aerosol is chiefly affected by the Brownian oscillations and gravity. Of course, wind speed and turbulence also play an important part in stability in the field.

Dilute aerosols of fine solid particles that neither coagulate nor evaporate may be so stable as to persist almost indefinitely. For example, volcanic dust, which may be expelled into the air several miles above sea level and which has a particle size of about 0.3 microns, falls at the velocity of about 1 mile per year.

In Table 1, the terminal velocity of the fall of particles ranging in size from 0.2 to 1000 microns can be seen. The 0.3 micron particles fall with a velocity of 0.014 cm./minute. This velocity increases rapidly when the particles are larger than 30 microns.

Table 1 also contains a comparison of the weight of particles with size. A particle having a size of 0.2 microns has a weight of 4.2×10^{-9} mmg. For a particle to have a weight of about 1 mmg. (10^{-6} or 0.000001 grams) its size would have to be greater than 100 microns.

The deposition or collection of particles of one sort or another on various objects, as trees, crops, or buildings, can be of considerable importance to farmers and insect control engineers.

TABLE 2

Factors Affecting the Efficiency of Collection of Aerosol Particles On a Surface in an Aerosol Stream

1. Particle inertia
2. Interception
3. Electrostatic attraction
4. Settling
5. Random molecular motion of Brownian diffusion

Aerosol particles tend to flow around obstacles by following the streamlines of the gaseous medium (air). This is illustrated in Figure 1.

SMALL particles, at low wind speeds, will not intercept with an object or target. As the particles and wind speed increase, the inertia of the particles becomes greater and then they will not have the same tendency to follow the flow of the gas around the object. The factors affecting the efficiency of collection or deposition of particles in an air stream are outlined in Table 2.

FIGURE 2

Factors in Deposition of Aerosols (Deposit=SVD/T)

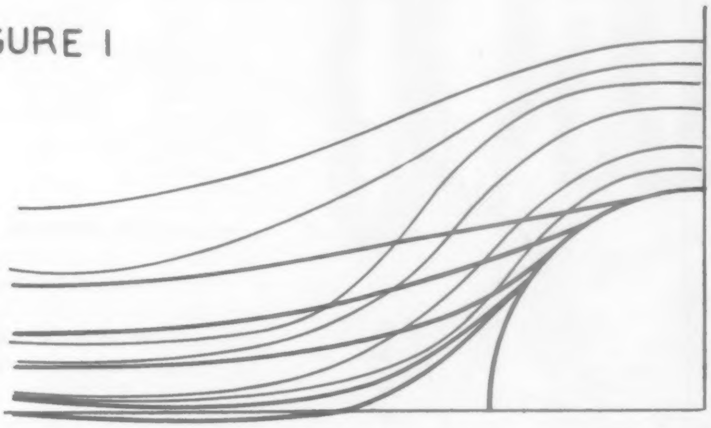
S=Particle size
V=Wind speed
D=Particle density
T=Target size

The factor having the greatest practical effect on the deposition of particles is inerita. This may be illustrated by the simplified relationship shown in Figure 2.

It can be seen in this relationship that deposition increases with (1) wind speed; (2) particle density; and (3) particle size. Deposition increases as the size of the target decreases.

That this relationship is true has been demonstrated by various investigators. Ranz and Wong studied the role of (1) particle size; (2) wind speed; and (3) target size on the efficiency of aerosol deposition. Their data, summarized in Table 3, indicates clearly that per cent deposition increases with particle size and wind speed and decreases with target size. At 3 mph, deposition on a 0.08 mm. wire increases from 34% for 3.7 micron particles to 93% for 27 micron particles. For the same sized

FIGURE I



PARTICLE TRAJECTORIES AROUND CYLINDER

TABLE 3

Collection of Aerosol by Wires

Wind Speed		**Per Cent Efficiency**			
	MMD	**0.08 mm.**	**0.25 mm.**	**1.0 mm.**	**9.0 mm.**
mph	**micron**	**wire**	**wire**	**wire**	**wire**
	3.3	5.3	1.9	0.5	0.2
0.9	7	34	18	8.8	1.4
	10	52	32	13	2.0
	15	75	50	25	4.3
	3.7	34	20	8.4	0.7
	7.5	69	47	25	2.6
3	13	89	69	40	7.6
	27	93	85	54	15
	3.7	46	31	16	2.1
	7.5	65	57	42	11
8	13	87	73	53	19
	27	100	84	64	28

target and a particle size of about 3.5 microns, deposition increased from 5.3% at 0.9 mph to 46% at 8 mph. While, at 3 mph, deposition of a 3.7 micron particle decreases from 34% for 0.8 mm. target to 0.7% for a 9.0 mm. target.

In Table 4 is listed the high flow rates needed to collect aerosol particles, of several sizes, in the cascade impactor. The cascade impactor is an instrument that can be considered as a multiple-jet sampler. This instrument employs a series of jets of decreasing areas and collecting slides arranged in tandem. Streamline design and the use of rectangular orifices permit the continuous flow of an air stream through the instrument with a minimum of loss and with high collection efficiencies at each orifice.

TABLE 4

Velocity vs. Particle Size Impacted

Velocity	**Particle Size**
mph	micron
4.8	11.0
23.4	7.0
65	2.3
172.5	1.3

Air is drawn through the instrument at a constant rate (about 14 liters/min.) and, since the orifice areas progressively decrease, the velocity and thus the efficiency of separation of the particles at each stage increases. Particles are deposited on successive slides through their inability to follow the course of the air stream. In Table 4, it can be seen that a flow rate of about 5 mph is needed to collect 11.0 micron particles with good efficiency; this flow must be increased to 172.5 mph to collect 1.3 micron particles.

Asset and Pury studied the effect of wind speed and particle size on deposition on human arms. Their data, show in Table 5, indicates that 6 micron particles are needed for deposition to occur on arms.

They also demonstrated that the hairs on an arm play an important part in the collection of areosol particles. Hairy arms collect almost 10 times as much material as hairless arms.

Thus, one can say that from the standpoint of a farmer dusting his crops or orchard, the greater the size, weight, and velocity of the particles, the greater will be the deposition of insecticide on his trees and crops. This also means the greater will be the likelihood of the contamination of his clothing and skin.

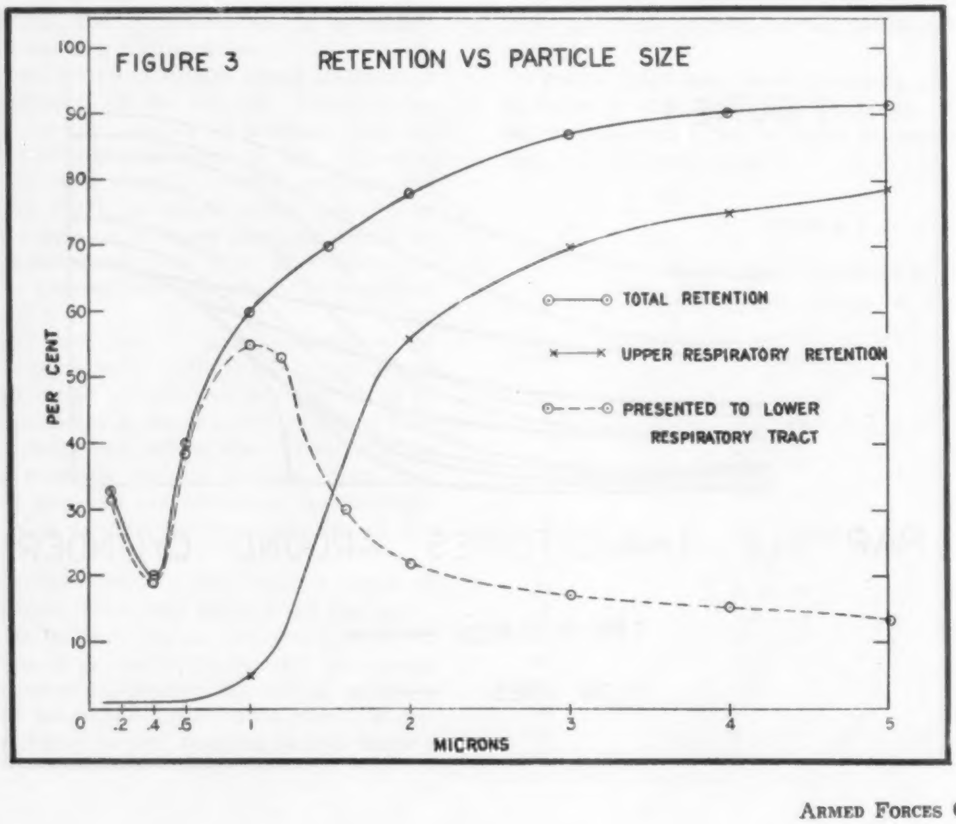


TABLE 5

Deposition of Liquid Aerosols on Human Arms

MMD	MPH	Percent Efficiency
(μ)		
		Hairy Surface of Arm
6.5	5	0.6
6.5	5	0.6
6.5	5	0.6
6.5	5	0.9
1.3	5	0
6.5	2	0.2
1.6	10	0.1
		Hairless Surface
6.5	5	0.08

Of course, man is an infinitely large object in relation to the particles. Aerosol deposition on man is influenced by the hairiness of the skin and roughness of his clothing.

Any hazard that is associated with the particle size of any insecticide would also be true for radioactive particles that may reach the lower atmosphere close to the earth following an atomic or hydrogen blast.

If one is interested in spraying a forest, a swamp, or a field with an insecticidal aerosol to get rid of mosquitoes or other insects, it would be important to know what kind of coverage could be expected from various sized particles.

In Table 6, the results of LaMer show that the travel of DDT clouds through wooded or mash areas is dependent on particle size, wind speed, and density of foliage. By selection of proper conditions, the aerosol can be restricted to small areas measured in feet or carried over large areas measured in miles.

TABLE 6

Travel of Oil Aerosols

MMD	Terrain	Wind Speed	Inversion	Observed Distance
μ		mph		ft.
6	Dense forest	0.1	Fair	475
6-8	Light-dense forest	0-1.5	Good	475
6-8	Open marsh	1.5-3.0	Good	5200
6-12	Light-dense forest	0.3-1.5	Poor	840
10-14	Light forest	0.3	Poor-Fair	1200
12-14	Vegetated marsh	3	Fair	2600
12-14	Vegetated marsh	1	Good	3200
25 (many 40 & over)	Open beach	5-7.5	Good	Most rained out within 35 ft.

The fraction of an aerosol cloud remaining airborne under two different conditions is shown in Table 7. *Lapse* is a condition when there is a decrease in air temperature with an increase in height. The ground is warmer and strong currents are present and cloud will disperse rapidly but remain airborne. *Inversion* is a condition when air temperature increases with height, the ground being cooler. There is little turbulence and the cloud does not disperse readily. However, these conditions favor the fall-out of the aerosol particles.

Again it is demonstrated that the distance a cloud will travel is dependent on wind speed and particle size. With a wind speed of 5 mph, under lapse conditions, 0.8 micron particles remain airborne for a least 10,000 yards; even 59% of the 24 micron particles are airborne at that distance. At 2 mph under inversion conditions, 0.8 micron particles are airborne at 10,000 yards, but as the particles increase in size, there is a much more rapid fall off in the number of particles remaining airborne with distance from the source of the cloud.

TABLE 7

The Fraction of Agent Remaining Airborne of Aerosol Clouds Under Two Different Atmospheric Conditions

Distance Downwind (yards)	(lapse), V=5 mph Drop diameter (microns)				(inversion), V=2 mph Drop diameter (microns)			
	0.8	8	12	24	0.8	8	12	24
100	0.99	0.98	0.96	0.85	0.99	0.89	0.76	0.32
500	0.99	0.96	0.94	0.78	0.99	0.83	0.64	0.16
1,000	0.99	0.96	0.93	0.74	0.99	0.78	0.58	0.11
5,000	0.99	0.95	0.90	0.65	0.99	0.69	0.42	0.03
10,000	0.99	0.95	0.88	0.59	0.99	0.63	0.37	0.02

The data from Tables 6 and 7 indicate that particles in the size range of 25 to 40 microns would give good coverage if one were trying to spray a small wooded or open area. The particles would tend to fall out rapidly as rain droplets within 50 feet.

Ten micron particles give appreciable vertical and horizontal deposition and do not tend to follow streamlines around trees or insects. This sized particle will travel for about a mile in open terrain and 1000 feet in a wooded area, at wind speed of 1 to 3 mph.

In air pollution and industrial toxicity studies, particle size is of prime importance since the entry of particles into the respiratory tree, the portion of an inhaled aerosol which is retained in the respiratory tree, and the depth to which the aerosol will penetrate before deopsition are related to particle size.

Particles below 15 microns are inhaled with an efficiency of 100%. When particles are above 50 microns or greater, they do not enter the nose. This data indicates that when particles have sufficient inertia they tend to continue in their course and resist inhalation into the nose unless the particle is traveling a path directed into the nares.

Of those particles entering the nose, there exists a size which is least retained by the respiratory tree. Findeisen calculated this theoretical size to be about 0.4 microns. Below this size, retention increases because of Brownian movement. Above this size, retention is increased by impaction and sedimentation.

The curves shown in Figure 3 are a composite of the data of several investigators (VanWijk, LaMer, Brown, Hatch, Altshuler, and Landahl). These curves are in good agreement with Findeisen's theoretical values.

By *total* retention is meant the retention of particles throughout the entire respiratory tree regardless of site. By *upper respiratory* retention is meant the retention that occurs in the area of the nasal passages.

These data show that retention (both total and upper respiratory) increases with particle size. Total retention decreases with size, down to about 0.4 microns and then tends to increase again. This last point, at 0.14 microns was attained recently by Altshuler, et al.

It can be seen that the upper respiratory retention begins to drop rapidly from about 50% at about 2 microns to about 5% for 1 micron particle. Below 1 micron retention drops off at a much lower rate.

If we subtract the per cent upper respiratory retention from the total retention for the various particle sizes, we can obtain another curve. This curve represents that portion of an inhaled aerosol that is presented to the lower portions of the respiratory tree.

This curve also shows that of all particles inhaled, those having the size of 1 micron have the best chance of going through the nose and of being retained in the lower portions of the respiratory tree.

The data in Table 8 shows a distribution pattern of inhaled particles ranging in size from about 0.8 to 16.6 microns. This distribution pattern is in terms of the number of particles of each size. It can be seen that of all the oil particles found in the mice that the 0.8 micron size make up about 39% and that about 32% of the particles reach the alveoli.

TABLE 8

Numerical and Mass Distribution of Corn Oil Particles In Mice Lungs

Size (micron)	% Lung		% Bronchi		% Terminal Bronchi and Alveoli Ducts		% Alveoli	
	No.	Mass	No.	Mass	No.	Mass	No.	Mass
0.8-2.5	80	11	24	4	26	4	30	3
3.3-10	19	72	10	46	7	21	2	5
12-17	1	17		17				
TOTAL	100	100	34	67	33	25	32	8

Calculation of the relative mass distribution of the particles in the various areas of the lung indicate that in terms of mass, only 8% reaches the alveoli, 25% the terminal bronchi and alveoli ducts, and 67% the bronchi.

In summary, what does this mean to the individual who comes in contact with these small particles which are present in the atmosphere we breathe.

To the farmer who is interested in spraying his crops with DDT it means that he has to have a rather large particle if he wants to spray his crops or orchard and not his neighbors.

To the industrial hygienist and plant physician it means that he has to keep a close account of the size of particles in his plant if some product, as silica, uranium dioxide, or any other substance that may cause lung damage is being used.

To one interested in making a smoke screen, he must see that his particles are small so that he gets the best coverage with the last amount of substances.

To the doctor in the hospital, it means that if he is trying to spray an antibiotic into an infected lung, he needs a small particle to reach the infected site.

To the man living beyond the blast areas of atomic or hydrogen explosion, it means that his chances of surviving may be dependent on the fallout of such an explosion. This fallout will, of course, be dependent on the size of the particles.

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CHEMICAL WARFARE IN CIVIL WAR

(Continued from Page 27)

"Experiment alone can determine whether this shell has any practical merit. Possibly, I overrate its value; but it must not be forgotten [sic], that while its does the work of an ordinary shell, it also carries with it a force against whose effect the most skillful military engineering can not possibly make any adequate provision.

"As to the moral question involved in its introduction, I have, after watching the progress of events during the last eight months with reference to it, arrived at the somewhat paradoxical conclusion, that its introduction would very much lessen the sanguinary character of the battlefield, and at the same time render conflicts more decisive in their results.

"If I have erred, I have, at least meant well."

Doughty showed remarkable foresight in proposing chlorine as a war gas. The German army used this gas to launch the first gas attack at Ypres in 1915. The German success, however, is no reason for assuming that the North would have been equally successful in 1862. With the mechanical equipment available at that time, Northern contractors would have had difficulty manufacturing and filling such shells. The shells could not have held much chlorine, and this fact, coupled with the slow rate of fire, inaccurate firing, and the fact that chlorine diffuses into the air, would have made it difficult to saturate Confederate positions with gas. Chlorine shells undoubtedly would have brought some confusion to Confederate positions the first time they were used, but Southern soldiers would not have been in much trouble once the shock of surprise had worn off. Doughty had what, with hindsight, looked like a good idea; but his shells may have been more trouble than they were worth.

In addition to suggestions for chemical agents, the Civil War brought forth a number of ideas on "Greek Fire," as incendiary mixtures were then popularly called. Some ingenious Northerners even went a step further and conceived the idea of combination poison gas—incendiary shells, if we may judge by the following passage taken from an article, "Destructive Fire Shells," in *Scientific American*, January 11, 1862: "Several incendiary and asphyxiating shells have been invented for the purpose of scattering liquid fire and noxious fumes around the space where they explode."

It was the filling for such a shell that an officer known to us only as Captain E. C. Boynton may have had in mind when he dropped the following paragraphs into the article, "Greek fire and Other Inflammables," that he contributed to the *United States Service Magazine* in January 1864: "When a mixture of acetate of potash and arsenious acid is distilled at a low red heat, a colorless liquid heavier than water, of an excessively disagreeable odor, and actively poisonous, results, called Alkarsine, C_4H_6AsO. If this liquid be exposed to the air, it oxidizes, ignites, and throws off deadly fumes of arsenious acid."

"When Alkarsine is distilled with strong chlorohydric acid, and the product digested in a vessel containing zinc, water, and carbonic acid, a heavy oily liquid insoluble in water is produced, which takes fire the instant it is brought in contact with the air. If this substance, termed Kacodyl, $C_4H_6As_2$, was confined in glass globes or bottles, and dropped in the deck of a vessel, or thrust below, all the horrors of combustion and *deadly arsenical inhalations* would be realized, beside which the terrors of the Greek fire would be contemptible."

Cacodyl compounds were then relatively new, having been first prepared by the German chemist Robert Bunsen about twenty years before, and their odd properties attracted the attention of chemists much more so than today. This may account for the fact that Boynton was not the first to suggest the employment of cacodyl compounds in warfare. The British chemist, Lyon Playfair, had tried to persuade the British army to use cacodyl cyanide shells against the Russians ten years earlier during the Crimean War (see this JOURNAL, November-December 1957). Playfair and the British army kept the plan secret, and Boynton could not have known about it.

The ideas that we have been discussing for toxic and harassing gases, cloud and shell attacks, seem familiar because they were used in the battlefields of France from 1915 to 1918. But one idea that popped up in the Civil War has never been tried; to anesthetize your enemy and take him prisoner.

It was after the battle between the Monitor and the Merrimac in March, 1862, when Southerners were considering ways of overcoming the Federal ironclad that someone, in seriousness or jest, thought of chloroform. The Merrimac would come along side of the Monitor, then a boarding party would wedge the turret fast and pour chloroform through all the observation slits. When the Northern sailors were asleep the Merrimac would tow the Monitor back to Norfolk. The Monitor and Merrimac never met again, but what a sensation it would have caused if the Merrimac had come steaming into Norfolk with the Monitor and a crew of snoring sailors wallowing along in the rear.

The chloroforming of the Monitor is the only Southern idea on chemical warfare that we have come across. This is not to say that the inventors of the Confederacy lacked ingenuity or interest, but rather that there are fewer Southern records and that they have been subjected to less scrutiny. Our knowledge of Northern ideas is better, as the examples that we have listed here testify, but there are certainly some that have been overlooked. Generally speaking we seem to know less about Civil War ideas on chemical warfare than on any other category of munitions. But with the growing interest in the history of the period, and the approaching centenary of the war, it is possible that researchers will uncover additional examples to place along side of those we have mentioned here.

Biographical Notf

Forrest Shepherd's letter to Abraham Lincoln is in the National Archives. The biographical sketch of Shepherd is from *Obituary Record of Graduates of Yale University . . . . 1880-90* (New Haven, 1890), p. 490.

John Doughty's letter to the War Department is in the National Archives.

Capt. C. E. Boynton's article, "Greek Fire and Other Inflammables," may be found in the *United States Service Magazine*, January 1864, pp. 50-55.

The anonymous article, "Destructive Fire Shells," may be found in *Scientific American* [new series] 6, 25 (Jan. 11, 1862).

The chloroforming of the Monitor was mentioned in a letter from Commodore L. M. Goldsborough, Hampton Roads, to Assistant Secretary of the Navy Gustavus V. Fox, April 28, 1862, published in *Confidential Correspondence of Gustavus Vasa Fox*, (edited by Robert M. Thompson and Richard Wainwright) (New York, 1918), Vol. I, p. 264.

CHEMICAL CORPS NEWS

SEVENTH ARMY TO CONDUCT A SERIES OF CBR COURSES

VAIHINGEN, Germany—Nearly 300 unit CBR officers from Seventh Army will attend a 40-hour Chemical, Biological and Radiological School at Kafertal, Germany this spring, Army Commander Lieutenant General Bruce C. Clark announced here recently.

The first of the eight one-week sessions will open March 10, and will be conducted by the 4th Chemical Battalion (Smoke Generator) in Kafertal. Major James J. Dearth, Jr., 4th Battalion executive officer, has been named school commandant. Lessons will be divided between classroom and field locations.

One CBR officer from each Army Troops company or battery-sized unit and one radiological defense officer from each battalion and group will attend. Each class will have a capacity of 40 students. Succeeding classes will begin on alternate weeks, March 24, April 7, April 21, May 5, May 19, June 2 and June 16.

General Clarke emphasized the need for extensive CBR schooling in an article published in the January, 1958, issue of *Army* magazine. "An offensive and defensive capability must be retained," he stated in regard to chemical support of a pentomic field army. "Units must have decontamination equipment within the unit and be trained in its use. There must be expanded radiological monitoring capability," General Clarke wrote.

CBR devices, detection and general training will be stressed. Instructors will be provided by the 4th Battalion under the technical supervision of Colonel Sam Efnor, Jr., Seventh Army chemical officer.

COL. LEONARD C. MILLER HEADS N. Y. PROCUREMENT DISTRICT

Colonel Leonard C. Miller has been appointed Commanding Officer of the U.S. Army Chemical Corps' New York Procurement District. The office at 290 Broadway is the Government's largest purchaser of chemical products for all branches of the services.

Colonel Miller was previously Deputy Commander of the U.S. Army Chemical Arsenal, Pine Bluff, Arkansas. A graduate chemist of Columbia University, he received his Masters Degree in Bacteriology from the University of Wisconsin.

A veteran of over 18 years service, Colonel Miller has served in the Panama Canal Zone, the European Theatre of Operations, and more recently as the U.S. Technical Representative for the Chemical Corps in the United Kingdom.

COL. HAMILTON IS CITED FOR TRIPARTITE CONFERENCE WORK

Lieutenant Colonel Allan C. Hamilton, deputy commander of the Chemical Warfare Laboratories at the Army Chemical Center, Md., and former president of A.F.C.A.'s chapter there, recently was awarded the Army Commendation Ribbon with Metal Pendant. Colonel Hamilton was cited for his part in planning and coordination of a Tripartite conference on toxic warfare, in which government representatives from the United States, Canada and Britain participated.

Picture above shows Colonel Hamilton receiving the decoration from Brig. General Walmsley, Chemical Center Commander, as Mrs. Hamilton looks on.

MAJOR LILA BARD RETIRES

ARMY CHEMICAL CENTER, Md. — Major Lila Bard, linguist and translator, who was Troop Information Officer at the Chemical Center, retired on January 31. Major Bard joined the Women's Army Corps in January 1943 and was appointed to her present grade, Regular Army, in April 1949. During World War II, she served in Europe. As Chief Secretariat, Reparations, Deliveries and Restitution Directorate, Military Government of Germany, she dealt with British, French and Russian delegates of the Allied Control Council. She came to the Chemical Center for duty in 1955.

Major Bard has been awarded the Army Commendation Ribbon with Metal Pendant. A resident of Westwood Village, California, before entering the Army, she assisted foreign writers and producers in translating screen plays for American audiences. Major Bard will make her home in Washington, D.C., and will take a position as a translator.

ACC COMMUNITY CHEST-RED CROSS APPEAL EXCEEDS $12,000 GOAL

ARMY CHEMICAL CENTER, Md.—The 1957 Community Chest-Red Cross Joint Appeal was officially ended at this post with the presentation of collections to agency representatives. The established $12,000 goal was exceeded by about $2,000.

Representing the Baltimore Joint Appeal headquarters, Mr. W. O. MacArthur accepted a check for $12,640 from Colonel Eugene G. Bennett, Deputy Post Commander. An additional $700 was collected for the Cecil County Community Chest and members of the Diamond Alkali Company, operating a leased manufacturing plant here, made $500 in returns diretly to the Baltimore chest earlier in the campaign.

SECOND CHEMICAL WEAPONS BATTALION REDESIGNATED

Announcement has been made of the redesignation of the Second Chemical Weapons Battalion stationed at Dugway Proving Ground as the Second Chemical Battalion (Smoke Generator).

The Second Chemical Weapons Battalion was organized after World War II and stationed at Dugway Proving Ground in 1953. It was a lineal descendant of the Chemical Troops of World War I. These specialized forces were first organized as the 30th Engineers, an organization of the Corps of Engineers. After the Regiment's assignment to the Chemical Warfare Service, its name was changed to First Gas Regiment. By World War II, a separate-battalion organization for these troops had supplanted the regiment. A number of such battalions equipped with 4.2 mortars were organized and, firing smoke and HE shell, served with distinction. But the special mantle and tradition of the World War I organization descended to one among them, the Second Chemical Mortar Battalion. It won a Presidential Citation for its service in Europe and a Distinguished Unit Citation for its operations in the Korean conflict.

AMONG THE AIR-MINDED AT A.C.C.

EDGEWOOD, Md.—Air-minded military and civilian personnel at the Army Chemical Center formed a Flying Club and have purchased a Piper Cub. Posing with the plane are (left to right) senior flight instructor Forrest Griffin; maintenance officer William Corder; publicity officer Private First Class Arthur Ginsburg; treasurer Private First Class Phillip Miller; secretary Mrs. Wretha Ricker; membership officer Seymour Selig; president Angelo Conti; and operations officer Captain William Vargovick.

AIDE TO GEN. WALMSLEY

ARMY CHEMICAL CENTER, Md. — Second Lieutenant Henry E. Jackson has been named aide-de-camp to Army Chemical Center Commander Brigadier General Harold Walmsley. A process engineer with the Thiokol Chemical Corporation at Huntsville, Alabama, before entering the Army, Lieutenant Jackson is a graduate of Vanderbilt University, Nashville, Tennessee.

AWARDS AT CML. C. SCHOOL

Mr. George D. Hoppe, an instructor in the Biological laboratory at the Chemical Corps School, Ft. McClellan, Ala., recently received a $200 award and certificate for "sustained superior performance."

Specialist third class Charles L. Prochnow, instructor in Biology at the School, received an award of $12.50 for a time-saving suggestion.

Mr. Carl D. Smith, an illustrator in the graphic arts division of the School, is a winner of a $10 award for a material-saving suggestion.

McCLELLAN PHYSICIST HONORED

FORT McCLELLAN, Ala.—Mr. Henry P. Whitten, a physicist in the U.S. Army Chemical Corps Field Requirements Agency here, recently received an "Outstanding Performance Award," presented by Col. R. D. Chapman, commanding officer of the agency. Mr. Whitten, a graduate of Mississippi State College and the University of Illinois, has served as project engineer on combat developments for the past year. His hometown is Weir, Miss.

NEW AIRCRAFT CLEANER SAFE FOR FISH AND GAME

BALTIMORE, Md., Jan. 27—To protect fish and game in local community streams, Air Force bases are now using a new alkaline water-base cleaner developed by the Air Research and Development Command to scrub airplanes. It consists of alkaline phosphates, silicates and wetting agents—the basic ingredients of the familiar household detergents.

Previously, a kerosene-base solvent was used which, rinsed with water, drained into sewer systems leading to local streams.

At large AF bases, the problem was further multiplied by the number and size of airplanes. An eight-jet B-52 "Stratofortress," for example, with a surface nearly equal to half an acre, requires approximately 5,000 gallons of water for one bath. Airplanes normally get twelve baths a year.

THE HISTORICAL CORNER

By Brooks E. Kleber
Historical Office, Chemical Corps

THE 92d CHEMICAL BATTALION AND COBRA

Although the chemical mortar battalion was dissolved during the Korean conflict and, indeed, currently there is talk of changing the caliber of the heavy mortar to 105 millimeters, the activities of the 4.2-inch mortar battalions in two wars have given the Chemical Corps much for which it can be proud.

Recently I had the opportunity to scan a manuscript volume to be published by the Office of the Chief of Military History. This volume included the period of breakthrough, in July 1944, from the constricted area of the Normandy Beachhead with its torturous hedgerow terrain. The exploits of the 92d Chemical Battalion in that operation immediately came to mind.

The code name for the breakthrough was COBRA. In order to get COBRA off on the right foot, planners ordered a massive strike against German frontline positions by heavy, medium, and fighter bombers. The 9th and 30th Division of VII Corps, ready to take advantage of the aerial blow, withdrew an appropriate distance behind the lateral road which formed the bombing line. Companies A and B of the 92d Chemical Battalion, commanded by Lt. Col. Ronald LeV. Martin, supported the 30th Division.

H Hour for COBRA was 1300 on 24 July. Weather that morning was overcast and the operation, dependent as it was upon a prelude of air bombardment, was postponed. However, word came too late for several of the air elements and 335 aircraft made their runs. Several hundred casualties among our own troops resulted from the bombings. General Bradley ordered the operation to be carried out the following day.

The morning of 25 July was clear and bright, and COBRA struck again. This time 1,500 heavy bombers dropped 3,300 tons of HE; over 380 medium bombers dropped an additional 650 tons; and 559 fighter bombers delivered 200 tons of bombs as well as a bonus of napalm. Unfortunately, some of the bombs again landed on American troops.

The two companies of the 92d, unscathed by the activities of the preceding day, this time were not so lucky. Company B was in the midst of firing a mission when hit by the bombs. Company A's positions, 100 yards away, also were struck. For two hours bombs fell in their areas. Nine of Company's A twelve mortars were destroyed, as was one-half of its ammunition. All vehicles in the area were demolished. Company A was able to salvage eight of its mortars and organized a platoon to fire a screening mission for the reorganization of the badly bombed infantry. This was done in spite of twenty-nine casualties, including six deaths.

Total American losses were 111 dead and 601 wounded. Lt. Gen. Lesley J. McNair, commander of the Army Ground Forces with headquarters in Washington, D.C., who was visiting the front, was killed while viewing the bombardment from a position just ahead of Company A; a news correspondent died in the Company B area.

Consternation within American lines was mild when compared to the destruction among enemy positions across the road. The VII Corps attack was only temporarily delayed, and infantrymen were quick to take advantage of the German disorganization. As far as the 92d was concerned, uncommitted Company C replaced Company A, less the one platoon mentioned above. Company B continued in support. As soon as Company A was refitted it relieved Company B. Thus did the 92d Chemical Battalion take part in COBRA, an offensive operation which surpassed even the fondest hopes of its planners.

N. Y. DISTRICT AGAIN IN ROLE OF SANTA CLAUS AT BELLEVUE

The United States Army Chemical Procurement District, New York, carried out its third annual "Operation Santa Claus" last Christmas for the children of Bellevue Hospital. More than a thousand toys were presented by Lt. Colonel John G. Appel, Commanding Officer, and Mr. William Huss, president of the Welfare Council, who are shown in the picture above along with two of the happy patients. A cash donation was also made for the children's outdoor play area. This collection is now a Christmas tradition for the District.

MEMORIAL DRIVEWAY NAMED FOR CAPT. WILHELM, KILLED IN KOREA

A driveway at Pine Bluff Arsenal, Arkansas, has been named Wilhelm Drive as a memorial to Captain Maurice E. Wilhelm, Chemical Corps, who was killed in action in Korea on November 2, 1950 while commanding Company B, 2nd Chemical Mortar Battalion.

Announcement of the action is contained in general orders of the Arsenal issued 8 January 1958 by Colonel Russell W. Dodds, Cml. C., the Arsenal Commander.

Captain Wilhelm enlisted in the Army on 8 January 1943, was commissioned 2nd Lieutenant AUS 1 December 1945, promoted to 1st Lieutenant 14 August 1947 and to Captain 1 November 1950.